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THE BRIDGEWATER TREATISES

ON THE POWER WISDOM AND GOODNESS OF GOD
AS MANIFESTED IN THE CREATION

TREATISE VII

ON THE HISTORY HABITS AND INSTINCTS OF ANIMALS

BY THE REV. WILLIAM KIRBY, M.A.

IN TWO VOLUMES

VOL I

" C'EST, LA BIBLE A LA MAIN, QUE NOUS DEVONS ENTRER DANS LE TEMPLE AUGUSTE DE LA NATURE, POUR BIEN COMPRENDRE LA VOIX DU CRÉATEUR."

GAEDE.

ON THE

POWER WISDOM AND GOODNESS OF GOD AS MANIFESTED IN THE CREATION OF ANIMALS AND IN THEIR HISTORY HABITS AND INSTINCTS

BY THE

REV. WILLIAM KIRBY, M.A. F.R.S. ETC.

RECTOR OF BARHAM.

VOL I

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DISCIP.
ANGLVS

LONDON
WILLIAM PICKERING
1835

C. WHITTINGHAM, TOOKS COURT, CHANCERY LANE.

TO THE RIGHT HONOURABLE

CHARLES,

BARON FARNBOROUGH,

KNIGHT GRAND CROSS OF THE ORDER OF THE BATH, A MEMBER OF HIS MAJESTY'S
MOST HONOURABLE PRIVY COUNCIL, AND ONE OF THE TRUSTEES
OF THE BRITISH MUSEUM,

THE FOLLOWING TREATISE,

BY HIS PERMISSION,

IS RESPECTFULLY INSCRIBED,

BY HIS LORDSHIP'S OBLIGED AND OBEDIENT SERVANT,

THE AUTHOR.

NOTICE.

The series of Treatises, of which the present is one, is published under the following circumstances:

The Right Honourable and Reverend Francis Henry, Earl of Bridgewater, died in the month of February, 1829; and by his last Will and Testament, bearing date the 25th of February, 1825, he directed certain Trustees therein named to invest in the public funds the sum of Eight thousand pounds sterling; this sum, with the accruing dividends thereon, to be held at the disposal of the President, for the time being, of the Royal Society of London, to be paid to the person or persons nominated by him. The Testator further directed, that the person or persons selected by the said President should be appointed to write, print, and publish one thousand copies of a work *On the Power, Wisdom, and Goodness of God, as manifested in the Creation; illustrating such work by all reasonable arguments, as for instance the variety and formation of God's creatures in the animal, vegetable, and mineral kingdoms; the effect of digestion, and thereby of conversion; the construction of the hand of man, and an infinite variety of other arguments; as also by discoveries ancient and modern, in arts, sciences, and the whole extent of literature.* He desired, moreover, that the profits arising from the sale of the works so published should be paid to the authors of the works.

The late President of the Royal Society, Davies Gilbert, Esq. requested the assistance of his Grace the Archbishop of Canterbury and of the Bishop of London, in determining upon the best mode of carrying into effect the intentions of the Testator. Acting with their advice, and with the concurrence of a nobleman immediately connected with the deceased, Mr. Davies Gilbert appointed the following eight gentlemen to write separate Treatises on the different branches of the subject as here stated:

THE REV. THOMAS CHALMERS, D.D.

PROFESSOR OF DIVINITY IN THE UNIVERSITY OF EDINBURGH.

ON THE POWER, WISDOM, AND GOODNESS OF GOD AS MANIFESTED IN THE ADAPTATION OF EXTERNAL NATURE TO THE MORAL AND INTELLECTUAL CONSTITUTION OF MAN.

JOHN KIDD, M.D. F.R.S.

REGIUS PROFESSOR OF MEDICINE IN THE UNIVERSITY OF OXFORD.

ON THE ADAPTATION OF EXTERNAL NATURE TO THE PHYSICAL CONDITION OF MAN.

THE REV. WILLIAM WHEWELL, M.A. F.R.S.

FELLOW OF TRINITY COLLEGE, CAMBRIDGE.

ASTRONOMY AND GENERAL PHYSICS CONSIDERED WITH REFERENCE TO NATURAL THEOLOGY.

SIR CHARLES BELL, K.G.H. F.R.S. L. & E.

THE HAND: ITS MECHANISM AND VITAL ENDOWMENTS AS EVINCING DESIGN.

PETER MARK ROGET, M.D.

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ON ANIMAL AND VEGETABLE PHYSIOLOGY.

THE REV. WILLIAM BUCKLAND, D.D. F.R.S.

CANON OF CHRIST CHURCH, AND PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF OXFORD.

ON GEOLOGY AND MINERALOGY.

THE REV. WILLIAM KIRBY, M.A. F.R.S.

ON THE HISTORY, HABITS, AND INSTINCTS OF ANIMALS.

WILLIAM PROUT, M.D. F.R.S.

CHEMISTRY, METEOROLOGY, AND THE FUNCTION OF DIGESTION, CONSIDERED WITH REFERENCE TO NATURAL THEOLOGY.

His Royal Highness the Duke of Sussex, President of the Royal Society, having desired that no unnecessary delay should take place in the publication of the above mentioned treatises, they will appear at short intervals, as they are ready for publication.

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[1] Owen's *Mem. on Naut. Pompil.* t. v. h.

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[1] Referred to by mistake as an *Octopus*, 308.

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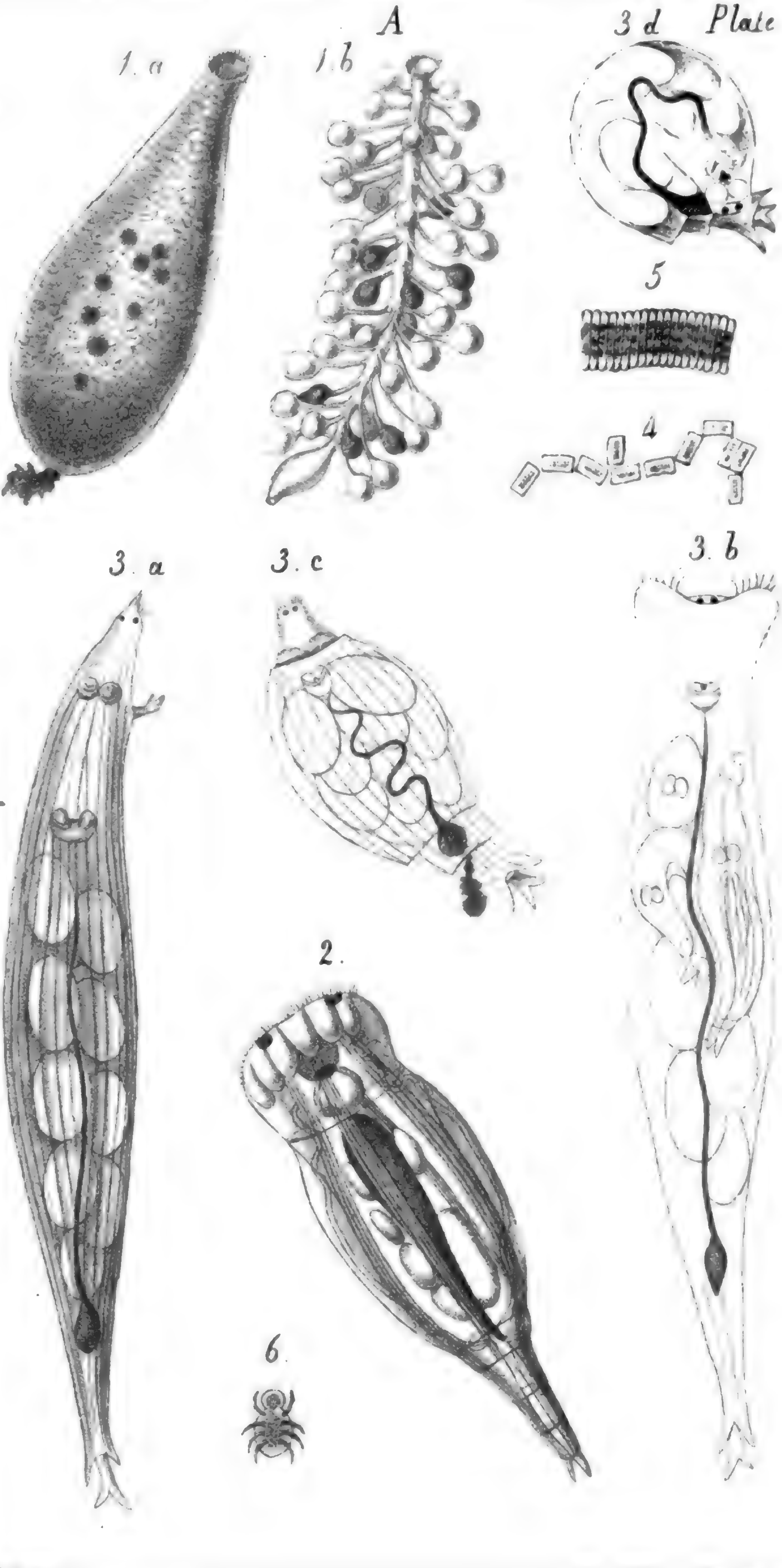
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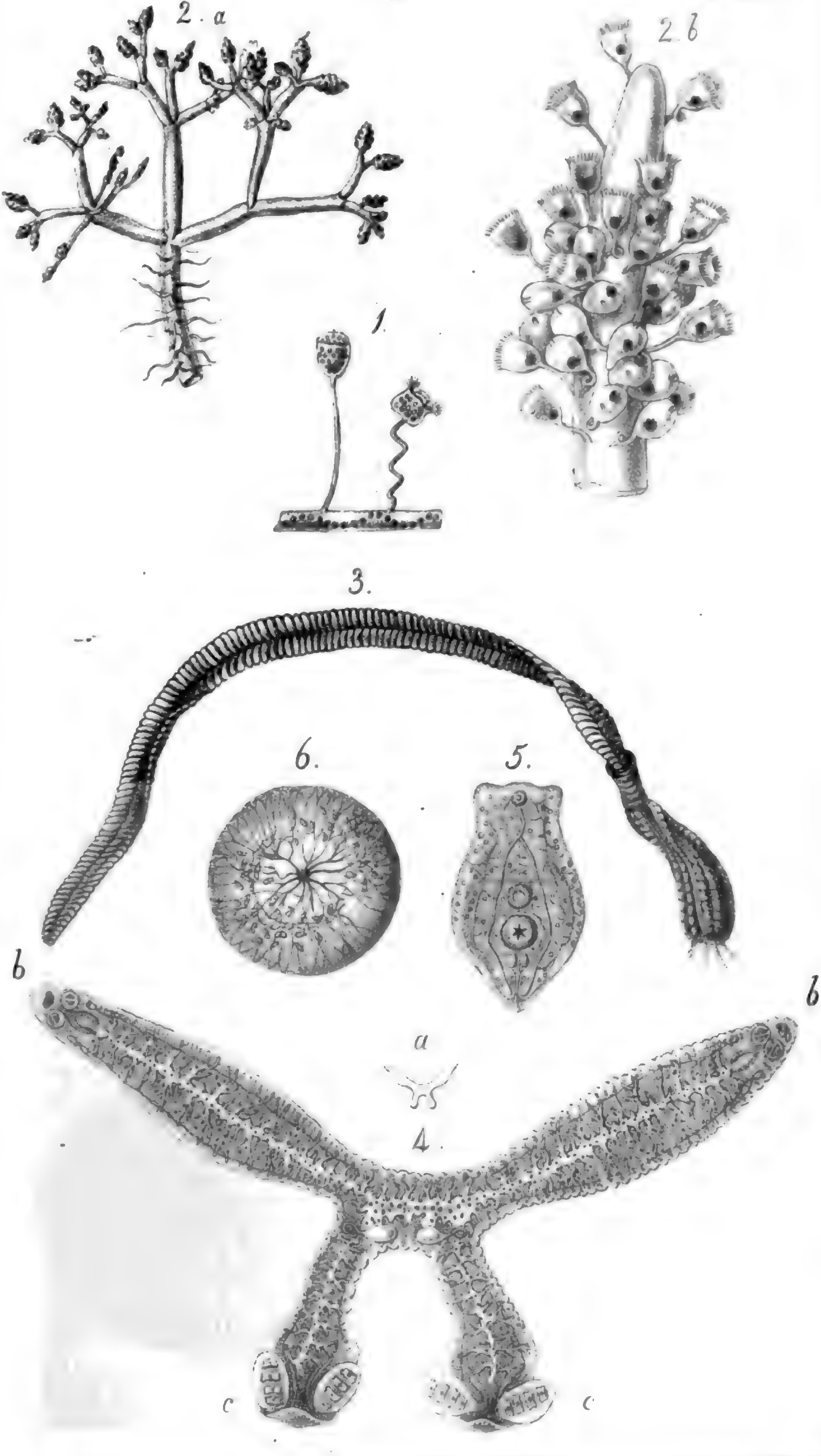
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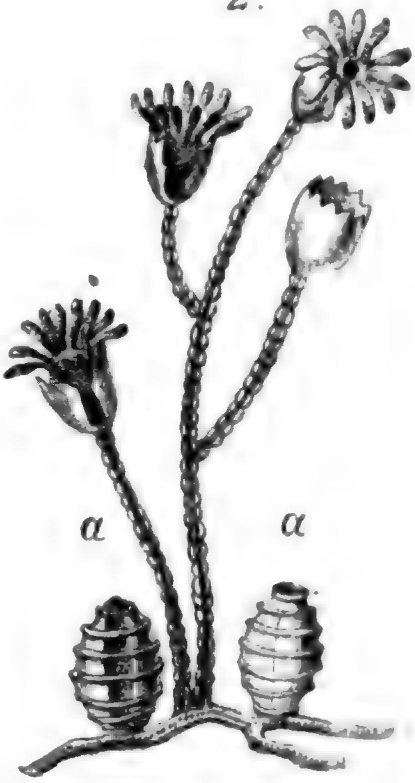

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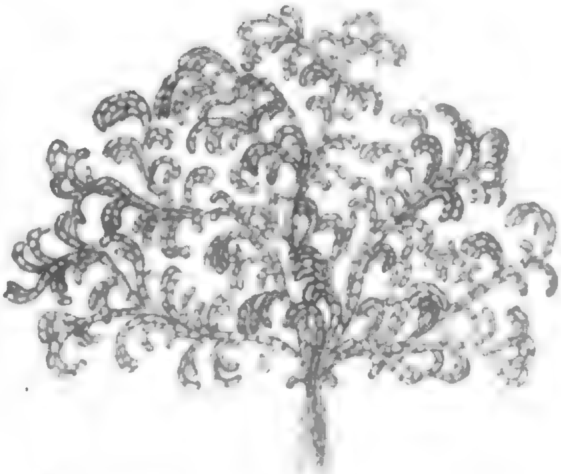

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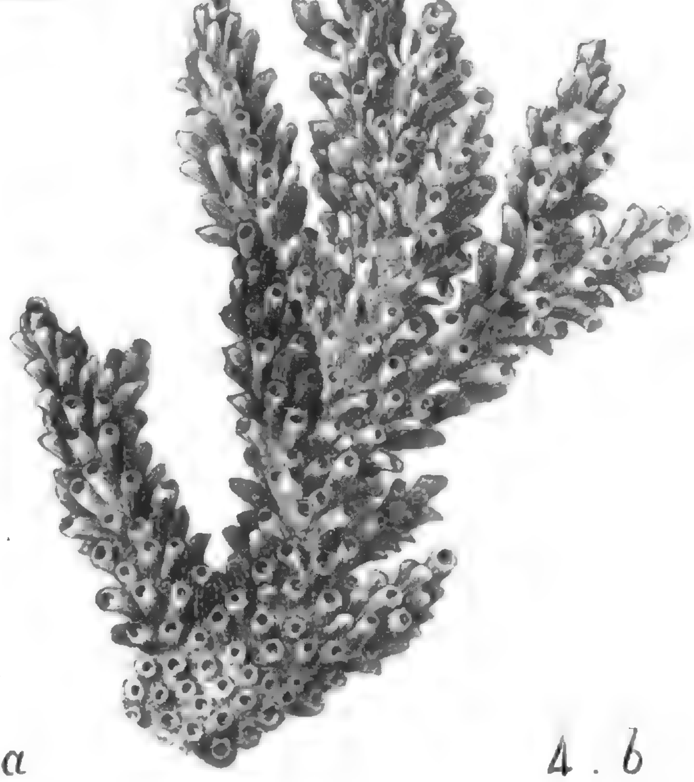

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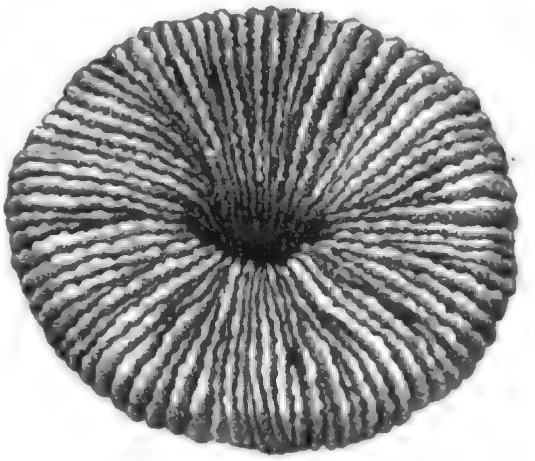

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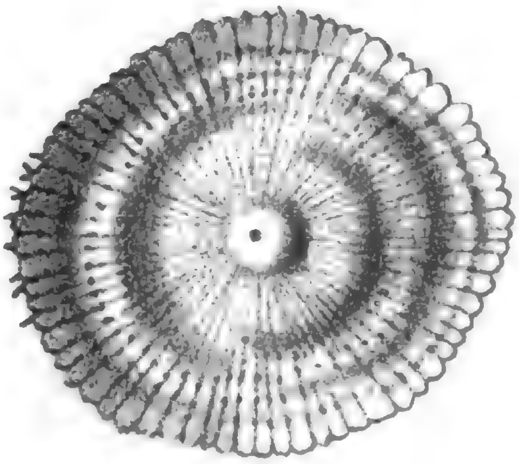

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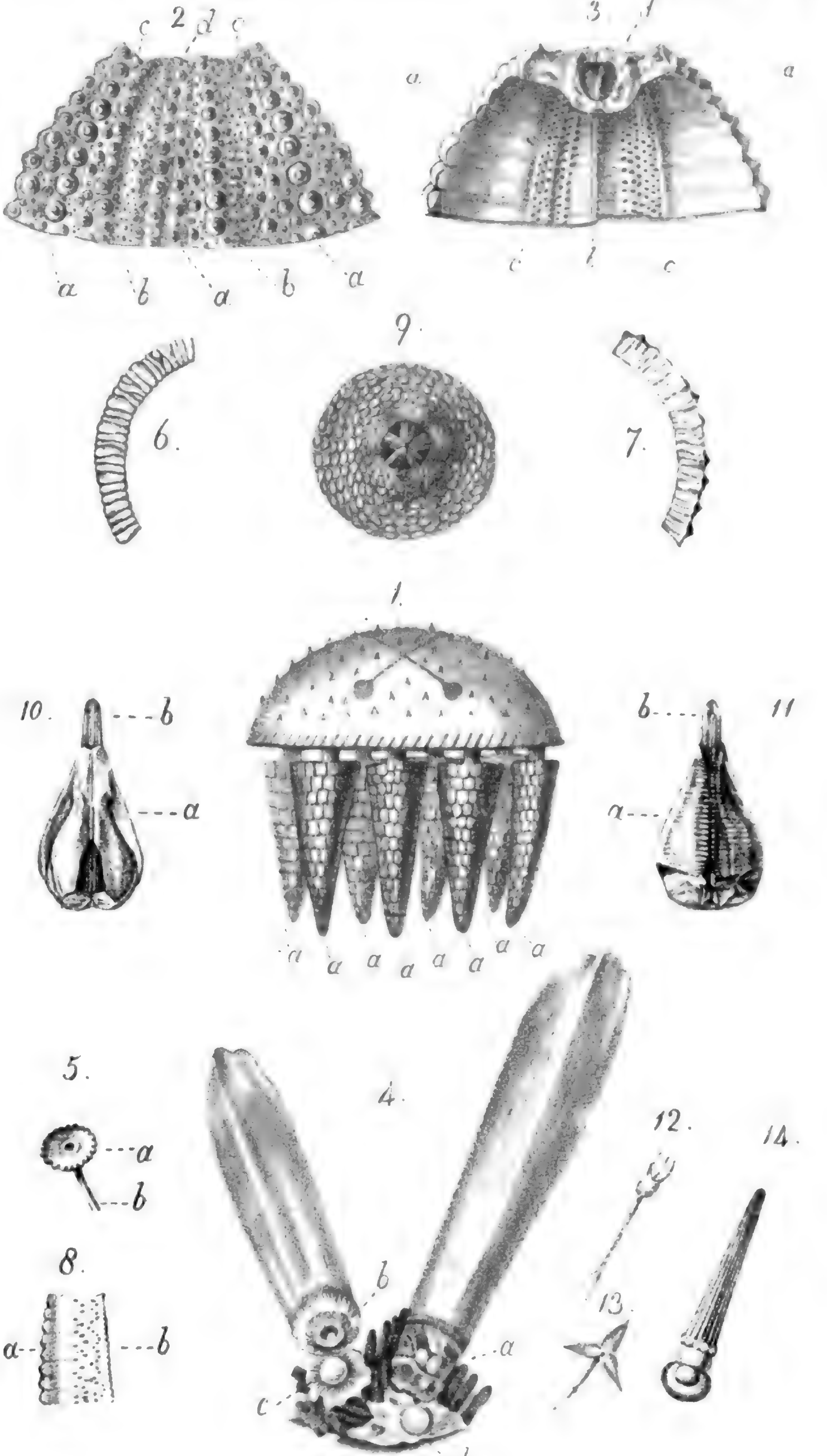

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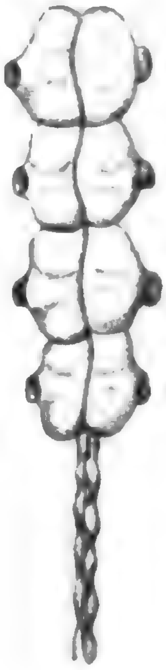

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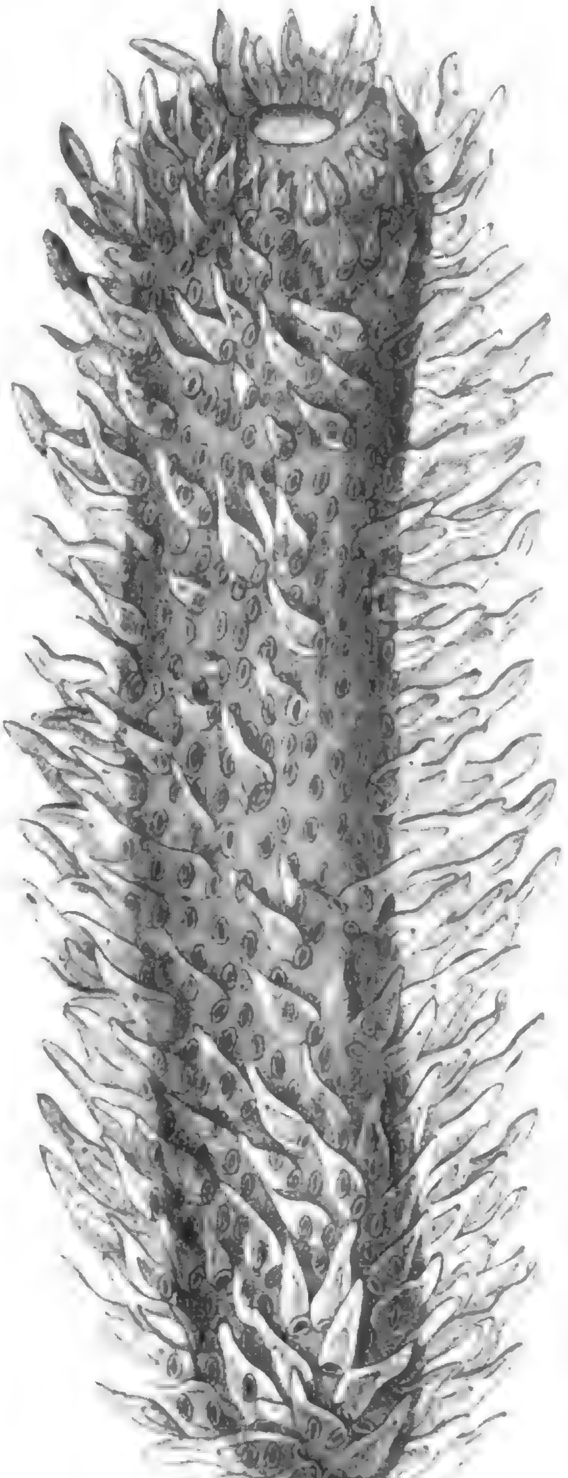

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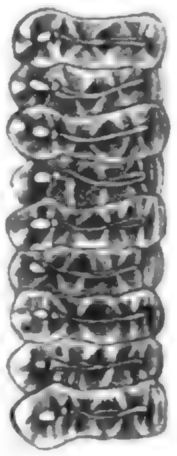

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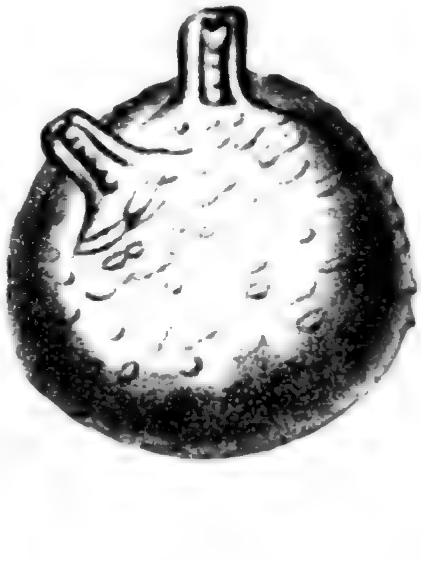

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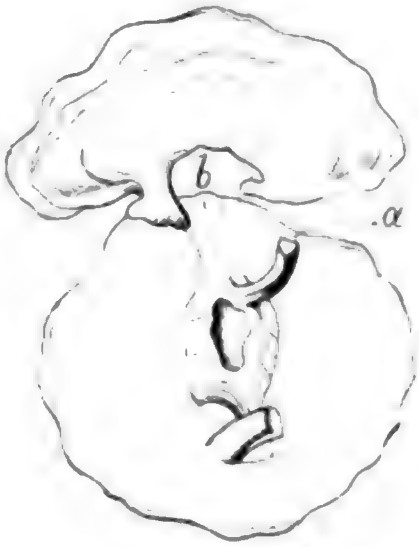

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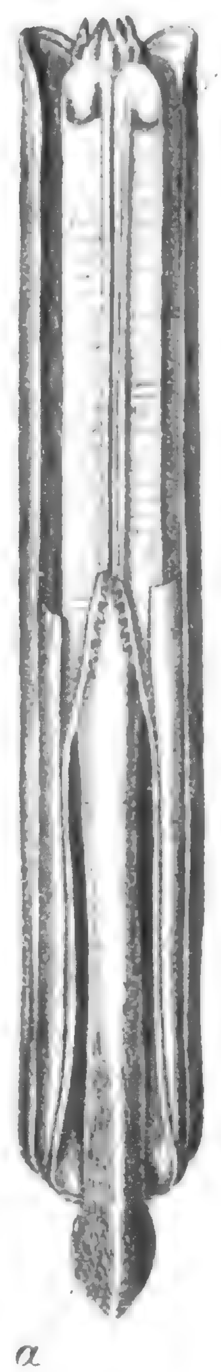

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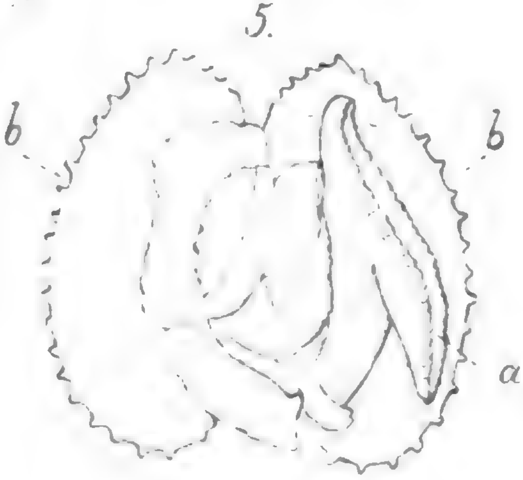

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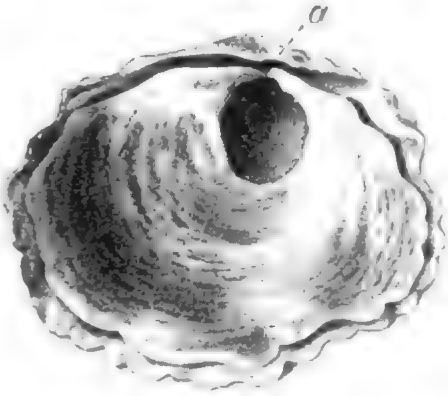

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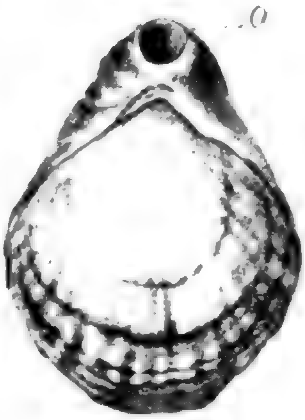

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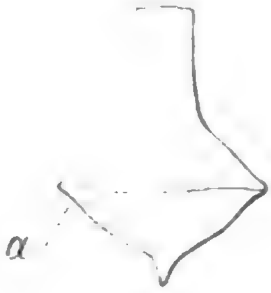

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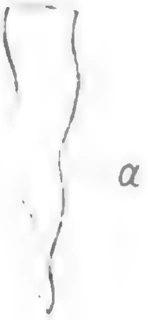

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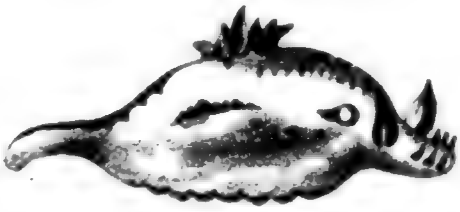

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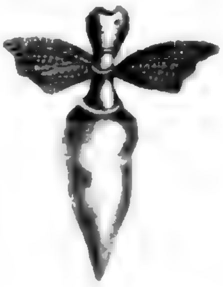

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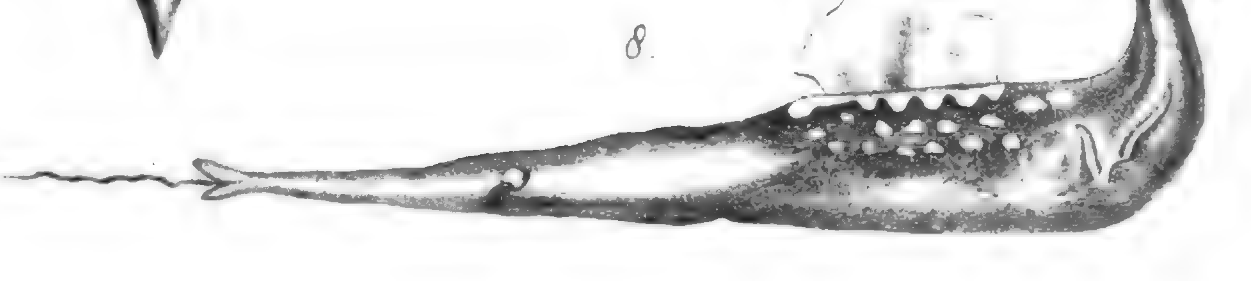

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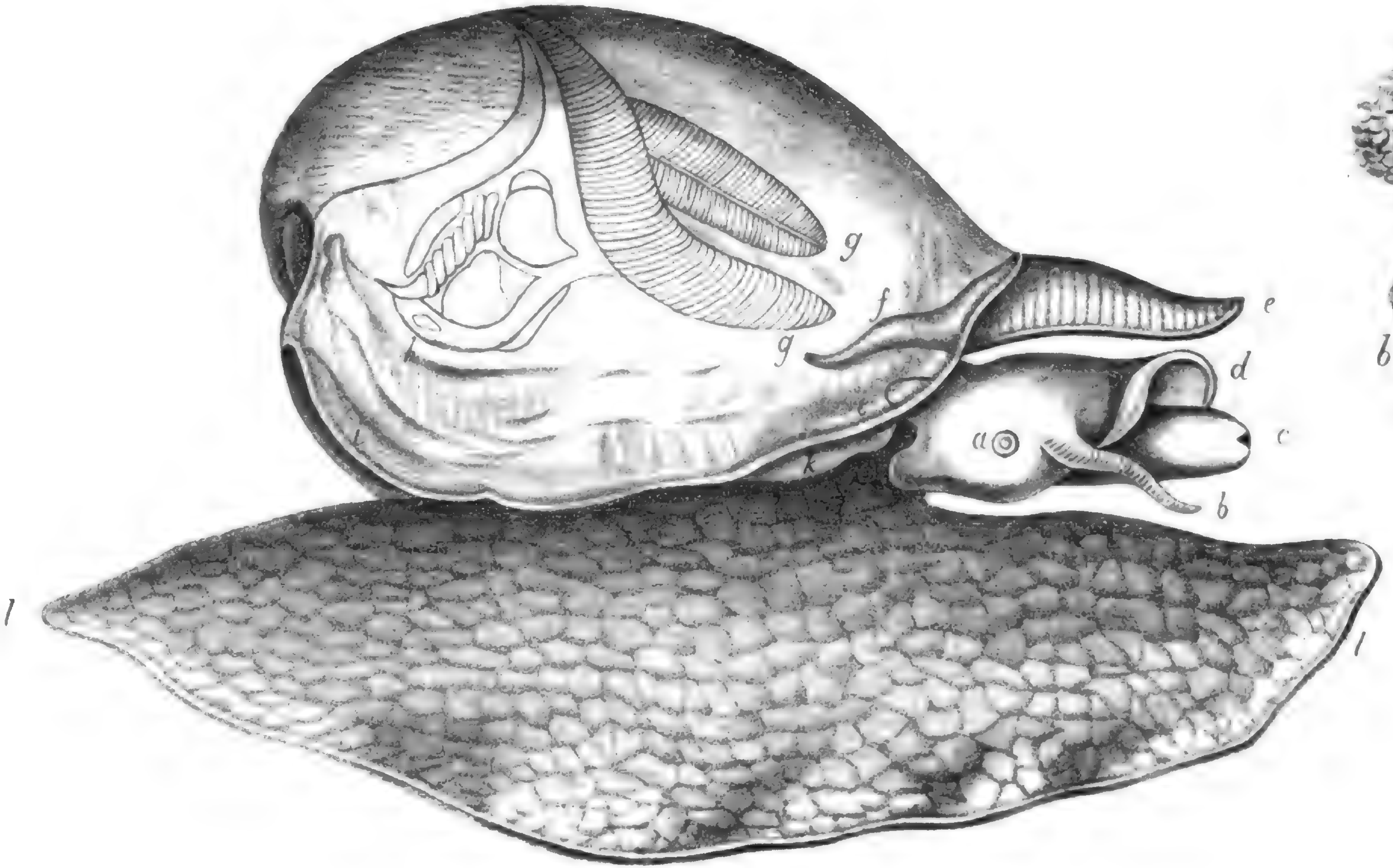
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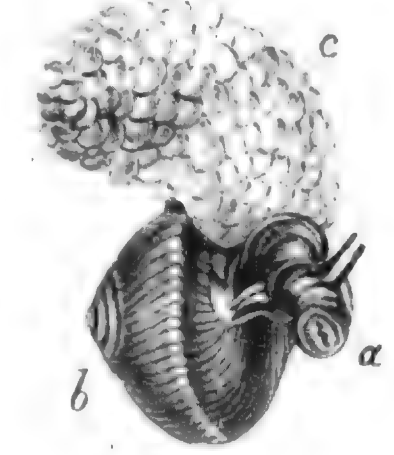

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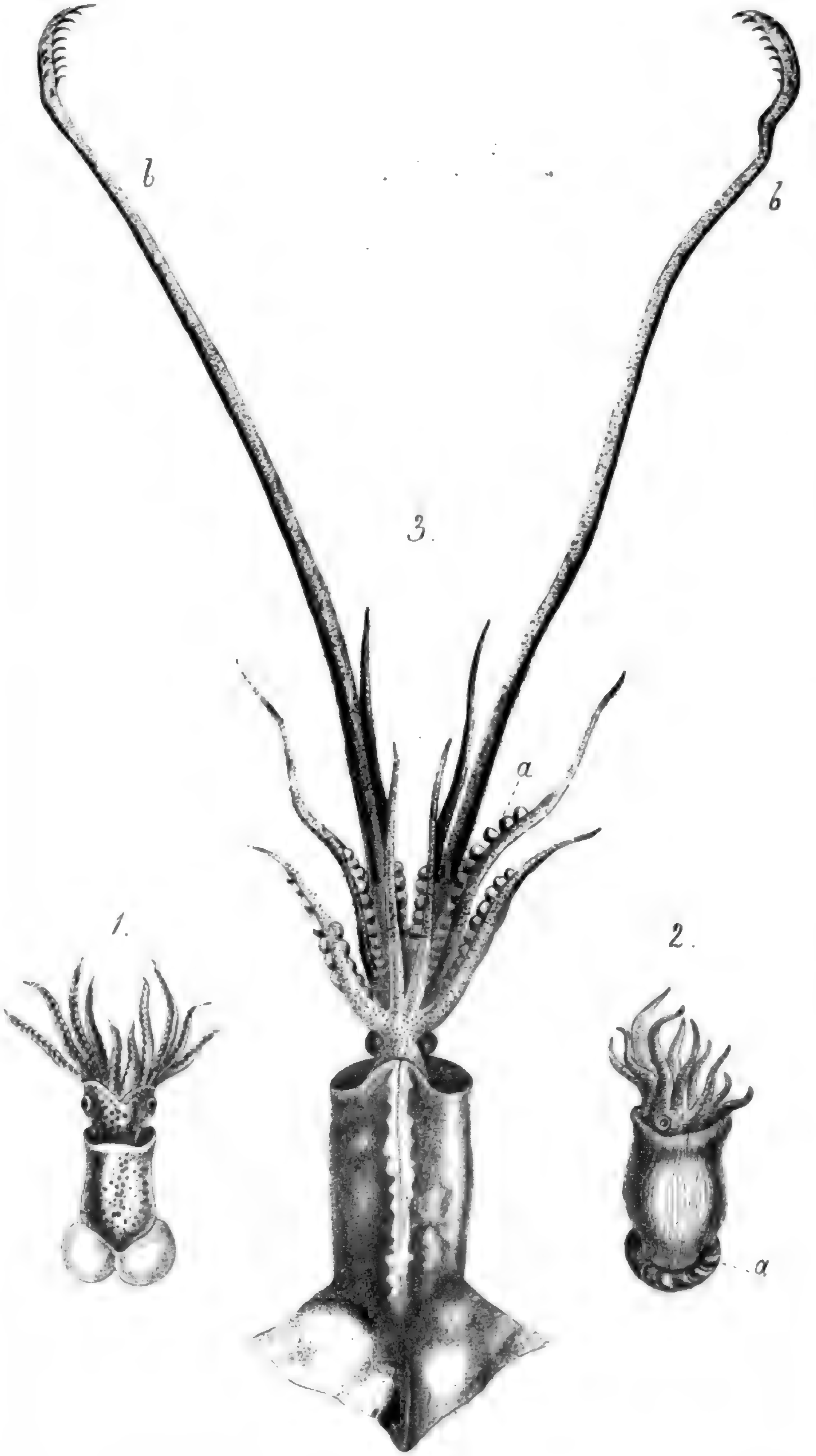

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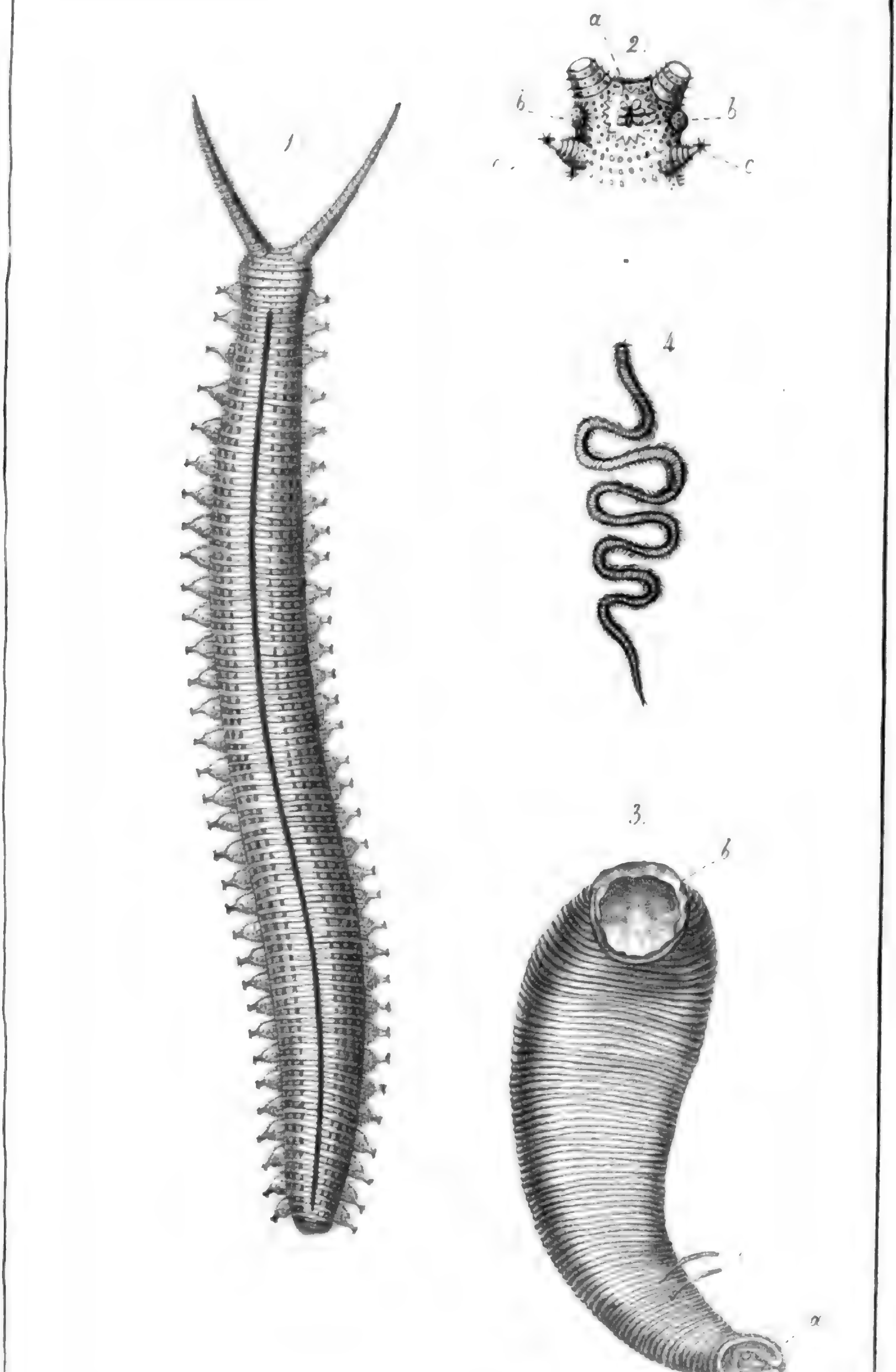
Plate VIII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INTRODUCTION.

THE *Works* of God and the *Word* of God may be called the two doors which open into the temple of Truth; and, as both proceed from the same Almighty and Omniscient Author, they cannot, if rightly interpreted, contradict each other, but must mutually illustrate and confirm, "though each in different sort and manner," the same truths. Doubtless it was with this conviction upon his mind, that the learned Professor,[1] from whom I have borrowed my motto, expresses his opinion—that in order rightly to understand the voice of God in nature, we ought to enter her temple with the Bible in our hands.

The prescribed object of the several treatises, of which the present forms one, is the illustration of the Power, Wisdom, and Goodness of the Deity, as manifested in the Works of Creation; but it is not only directed that these primary attributes should be proved by all reasonable arguments derived from physical objects, but also by discoveries ancient and modern, and *the whole extent of literature.* As the Holy Scriptures form the most interesting portion, in every respect, of ancient literature; and it has always been the habit of the author of the present treatise to unite the study of the *word* of God with that of his *works*;[1] he trusts he shall not be deemed to have stepped out of the record, where he has copiously drawn from the sacred fountains, provided the main tenor of his argument is in accordance with the brief put into his hands.

---

[1] The pious Heinrich Moritz Gaede, Professor of Natural History in the University of Liege.

Those who are disposed to unite the study of scripture with that of nature, should always bear in mind the caution before alluded to, that all depends upon the *right* interpretation, either of the *written word* or *created substance.* They who study the word of God, and they who study his works, are equally liable to error; nor will talents, even of the highest order, always secure a man from falling into it. The love of truth, and of its Almighty Author, is the only sure guide that will conduct the aspirant to its purest fountains. High intellectual powers are a glorious gift of God, which, when associated with the qualities just named, lead to results as glorious, and to the light of real unsophisticated knowledge. But *knowledge puffeth up*, and if it stands alone, there is great danger of its leading its possessor into a kind of self-worship, and from thence to self-delusion, and the love of hypothesis.

---

[1] See *Monographia Apum Angliæ*, i. 2, and *Introd. to Ent.* i. *Pref.* xiii. &c.

It is much to be lamented that many bright lights in science, some from leaning too much to their own understanding, and others, probably from having Religion shown to them, not with her own winning features, nor in her own simple dress, but with a distorted aspect, and decked meretriciously, so that she appears what she is not, without further inquiry and without consulting her genuine records, have rejected her and fallen into grievous errors. To them might be applied our Saviour's words, *Ye do err not knowing the Scriptures.* These observations apply particularly to two of the most eminent philosophers of the present age, one for the depth of his knowledge in astronomy and general physics ; and the other in zoology. It will be easily seen that I allude to La Place and Lamarck, both of whom, from their disregard of the word of God, and from seeking too exclusively their own glory, have fallen into errors of no small magnitude. It is singular, and worthy of observation, that both have based their hypothesis upon a similar foundation. La Place says, " An attentive inspection of the solar system evinces the necessity of some central paramount force, in order to maintain the entire system together, and secure the regularity of its motions."[1] One would expect from these remarks, that he was about to enforce the necessity of acknowledging the necessary existence of an intelligent paramount central Being, whose goings forth were co-extensive with the universe of systems, to create them at first, and then maintain their several motions and revolutions, so as to prevent them from becoming eccentric and interfering with each other,[2] thus—*Upholding all things by the word of his power.* But no—when he asks the question, What is the primitive cause?[1] instead of answering it immediately, he refers the reader for his hypothesis to a concluding note, in which we find that this *primitive* cause, instead of the Deity, is a nebulosity originally so diffuse, that its existence can with difficulty be conceived.[2] To produce a system like ours, one of these wandering masses of nebulous matter distributed through the immensity of the heavens,[3] is converted into a brilliant nucleus, with an atmosphere originally extending beyond the orbits of all its planets, and then gradually contracting itself, but at its successive limits leaving zones of vapours, which, by their condensation, formed the several planets and their satellites, including the rings of Saturn!![4]

---

[1] *System of the World,* E. Tr. ii. 330.

[2] *Ibid. Appendix,* concluding note.

It is grievous to see talents of the very highest order, and to which Natural Philosophy, in other respects, is so deeply indebted, forsaking the *Ens Entium*, the God of Gods, and ascribing the creation of the universe of worlds to a cause which, according to his own confession, is all but a non-entity. He speaks, indeed, of a Supreme Intelligence, but it is as Newton's god,—whom he blames for attributing the admirable arrangement of the sun, of the planets, and of the comets, to an Intelligent and Almighty Being,[1]—and of an Author of Nature, not, however, as the preserver and upholder of the universe,[2] but as perpetually receding, according as the boundaries of our knowledge are extended;[3] thus expelling, as it were, the Deity from all care or concern about his own world.

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[1] *System of the World*, E. Tr. ii. 328.

[2] *Ibid* 357. [3] *Ibid*. 332. [4] *Ibid*. 358.

While the *philosopher* thus became *vain in his imaginations*, the *naturalist* attempted to account for the production of all the various forms and structures of plants and animals upon similar principles. Lamarck, distinguished by the variety of his talents and attainments, by the acuteness of his intellect, by the clearness of his conceptions, and remarkable for his intimate acquaintance with his subject, thus expresses his opinion as to the origin of the present system of organized beings. "We know, by observation, that the most simple organizations, whether vegetable or animal, are never met with but in minute gelatinous bodies, very supple and delicate; in a word, only in frail bodies almost without consistence and mostly transparent." These minute bodies he supposes nature forms, in the waters, by the power of attraction; and that next, subtle and expansive fluids, such as caloric and electricity, penetrate these bodies, and enlarge the interstices of their agglutinated molecules, so as to form utricular cavities, and so produce irritability and life, followed by a power of absorption, by which they derive nutriment from without.[1]

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[1] *System of the World*, E. Tr. ii. 331.

[2] *Ibid.* 332.

[3] *Ibid.* 333.

The production of a new *organ* in one of these, so formed, animal bodies, he ascribes to a new *want*, which continues to stimulate; and of a new movement which that want produces and cherishes.[2] He next relates how this can be effected. Body, he observes, being essentially constituted of cellular tissue, this tissue is in some sort the matrix, from the modification of which by the fluids put in motion by the stimulus of desire, membranes, fibres, vascular canals, and divers organs, gradually appear; parts are strengthened and solidified;[1] and thus progressively new parts and organs are formed, and more and more perfect organizations produced; and thus, by consequence, in the lapse of ages a monad becomes a man!!!

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[1] *Anim. sans Vertèbr.* i. 174.

[2] *Ibid.* 181.

The great object both of La Place and Lamarck seems to be to ascribe all the works of creation to *second* causes; and to account for the production of all the visible universe, and the furniture of our own globe, without the intervention of a *first*. Both begin the work by introducing nebulosities or masses of matter scarcely amounting to real entities, and proceed as if they had agreed together upon the *modus operandi*.

As Lamarck's hypothesis relates particularly to the animal kingdom, I shall make a few observations upon it, calculated to prove its utter irrationality.

When, indeed, one reads the above account of the mode by which, according to our author's hypothesis, the first vegetable and animal forms were produced, we can scarcely help thinking that we have before us a receipt for making the organized beings at the foot of the scale in either class—a mass of irritable matter formed by *attraction*, and a *repulsive* principle to introduce into it and form a cellular tissue, are the only ingredients necessary. Mix them, and you have an animal which begins to absorb fluid, and move about as a monad or a vibrio, multiplies itself by scissions or germes, one of which being stimulated by a want to take its food by a mouth, its fluids move obediently towards its anterior extremity, and in time a mouth is obtained; in another generation, a more talented individual discovering that one or more stomachs and other intestines would be a convenient addition to a mouth, the fluids immediately take a contrary direction, and at length this wish is accomplished; next a nervous collar round the gullet is acquired, and this centre of sensation being gained, the usual organs of the senses of course follow. But enough of this.

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[1] *Anim. sans Vertèbr.* i. 184.

Let any one examine the whole organization and structure, both internal and external, of any animal, and he will find that it forms a *whole*, in which the different organs and members have a mutual relation and dependence, and that if one is supposed to be abstracted, the whole is put out of order and cannot fulfill its evident functions. If we select, as a well known instance, the *Hive-bee* for an example. Its long tongue is specially formed to collect honey; its honey stomach to receive and elaborate it either for regurgitation, or for the formation of wax; and other organs or pores are added, by which the latter can be transmitted to the wax pockets under its abdomen; connected with these, are its means and instruments to build its cells, either for store cells to contain its honey and bee-bread, or its young brood, such as the form of its jaws, and the structure and furniture of its hind legs. Now here are a number of organs and parts that must have been contemporary, since one is evidently constructed with a view to the other: and the whole organization and structure of the whole body forming the societies of these wonder-working beings, that I mean, of the males, females, and workers, is so nicely adjusted, as to concur exactly in producing the end that an intelligent Creator intended, and directing each to that function and office which he devolved upon them, and to exercise which he adapted them. Were we to go through the whole animal kingdom the same mutual relation and dependence between the different parts and organs of the structure and their functions would be found.

Can any one in his rational senses believe for a moment that all these adaptations of one organ to another, and of the whole structure to a particular function, resulted originally from the wants of a senseless animal living by absorption, and whose body consisted merely of cellular tissue, which in the lapse of ages, and in an infinity of successive generations by the motions of its fluids, directed here and there, produced this beautiful and harmonious system of organs all subservient to one purpose; and which in numerous instances vary their functions and organs, but still preserving their mutual dependence, by passing through three different states of existence.

Lamarck's great error, and that of many others of his compatriots, is materialism; he seems to have no faith in any thing but *body*, attributing every thing to a physical, and scarcely any thing to a metaphysical cause. Even when, in words, he admits the being of a God, he employs the whole strength of his intellect to prove that he had nothing to do with the works of creation. Thus he excludes the Deity from the government of the world that he has created, putting nature in his place; and with respect to the noblest and last formed of his creatures into whom he himself breathed the breath of life; he certainly admits him to be the most perfect of animals, but instead of a son of God, the root of his genealogical tree, according to him, is an animalcule, a creature without sense or voluntary motion, or internal or external organs, at least in his idea—no wonder therefore that he considers his intellectual powers, not as indicating a spiritual substance derived from heaven though resident in his body, but merely as the result of his organization,[1] and ascribes to him in the place of a soul, a certain *interior sentiment*, upon the discovery of which he prides himself.[2] In one of his latest descriptions of it, he thus describes the office of this internal sentiment: "Every action of an intelligent individual, whether it be a movement or a thought, or an act amongst the thoughts, is necessarily preceded by a want of that which has power to excite such action. This want felt immediately moves the internal sentiment, and in the same instant, that sentiment directs the disposeable portion of the nervous fluid, either upon the muscles of that part of the body which is to act, or upon the part of the organ of intelligence, where are impressed the ideas which should be rendered present to the mind, for the execution of the intellectual act which the want demands."[1] In fact Lamarck sees nothing in the universe but bodies, whence he confounds sensation with intellect. Our eyes certainly shew us nothing but bodies—their actions and motions, their structure, their form and colour; our ears the sounds they produce; our touch their degree of resistance, or comparative softness or hardness; our smell their scent; our taste their flavour; but though our senses can conduct us no further, we find a very active substance in full power within us that can. At a very early period of life we feel a wish to know something further concerning the objects to which our senses introduce us, which often generates a restless desire in the mind to gain information concerning the causes and origin of those things perceived by them; now this is the result of *thought*, and thought is no body, and though the thinking essence inhabits a body, yet we cannot help *feeling* that our thoughts are an attribute of an immaterial substance. Thought, discursive and excursive thought, that is not confined to the contemplation of the things of earth, things that are immediately about us, but can elevate itself to heaven, and the heavenly bodies, not only to those of our own system, but can take flights beyond the bounds of time and space, and enter into the Holy of Holies, and contemplate Him who sitteth upon the cherubim, the throne of his Deity. Thought, that not only beholds things present, however distant and removed from sense, but can contemplate the days of old and the years of many generations, can carry us back to hail with the angelic choirs, the birth-day of nature and of the world that we inhabit; or looking into the abyss of futurity, can anticipate the termination of our present mixed scene—chequered with light and darkness, good and evil—and the beginning of that eternal sabbath which remaineth for the people of God in the heavenly kingdom of Christ: thought that can not only take these flights, and exercise herself in these heavenly musings; but accompanied as she is, in our favoured race, with the gift of speech can reason upon them with a fellow mind, and by such discussion often elicit sparks of truth, that may be useful to enlighten mankind. Who can believe that such a faculty, so divine and god-like and spiritual, can be the mere result of organization? That any juxta-position of *material* molecules, of whatever nature, from whatever source derived, in whatever order and form arranged, and wherever placed, could generate thought, and reflexion, and reasoning powers; could acquire and store up ideas and notions as well concerning metaphysical as physical essences may as safely be pronounced impossible, as that matter and spirit should be homogeneous. Though the intellectual part acts by the brain and nerves, yet the brain and nerves, however ample, however developed, are not the intellect, nor an intellectual substance, but only its instrument, fitted for the passage of the prime messenger of the soul, the nervous fluid or power, to every motive organ. It is a substance calculated to convey instantaneously that subtile agent, by which spirit can act upon body, wherever the soul bids it to go and enables it to act. When death separates the intellectual and spiritual from the material part, the introduction of a fluid homogeneous with the nervous, or related to it by a galvanic battery can put the nerves in action, lift the eye-lids, move the limbs, but though the action of the intellectual part may thus be imitated, in newly deceased persons, still there are no signs of returning intelligence; there is no life, no voluntary action, not a trace of the spiritual agent that has been summoned from its dwelling. Whence it follows, that though the organization is that by which the intellectual and governing power manifests its presence and inhabitation, still it is evidently something distinct from and independent of it.

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[1] *N. Dict. D'Hist. Nat.* xvi. Artic. *Intelligence*, 344. comp. *Ibid.* Artic. *Idée*, 78, 80.

[2] *Ibid.* 332.

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[1] *N. Dict. D'Hist. Nat.* xvi. Artic. *Intelligence*, 350.

Mr. Lyell has so fully considered that part of Lamarck's hypothesis which relates particularly to the transmutation of species, and so satisfactorily proved their general stability, that it is unnecessary for me to enter more particularly into that subject, I must therefore refer the reader to that portion of his work.[1]

Let us lastly enquire, to whom or what, according to our author, God has given up the reins; whom he has appointed his viceroy in the government of the universe. *Nature* is the second power who sits on this viceregal throne, governing the physical universe, whom we should expect to be superior in intellect and power to angel and archangel—but no—he defines her to be—"An order of things composed of objects independent of matter, which are determined by the observation of bodies, and the whole amount of which constitutes a power unalterable in its essence, governed in all its acts, and constantly acting upon all parts of the physical universe."[2] And again, Nature he affirms consists of non-physical objects, which are neither beings, nor bodies, nor matter. It is composed of motion; of laws of every description; and has perpetually at its disposal space and time.[3]

With respect to the agency of this vicegerent of Deity, he observes that Nature is a blind power without intelligence which acts necessarily.[1] That matter is her sole domain, of which however she can neither create nor destroy a single atom, though she modifies it continually in every way and under every form,—and causes the existence of all bodies of which matter is essentially the base;—and that in our globe it is she that has immediately given existence to vegetables, to animals, as well as to other bodies that are there to be met with.[2]

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[1] *Principles of Geology*, ii. c. 1, 2.

[2] *N. Dict. D'Hist. Nat.* xxii. Art. *Nature*, 377.

[3] *Ibid.*

From these statements, though he appears to admit the existence of a Deity, and that he is the primary author of all things, yet he considers him as having delegated his power to *nature* as his vicegerent, to whose disposal he has left all material subsistences, and who, according to him, is the real creator of all the forms and beings that exist, and who maintains the physical universe in its present state. It is not quite clear what opinion he held with respect to the creation of matter, as he no where expressly ascribes it to God; though, since he excludes nature from it, we may infer, unless he thought it to be eternal, that he meant it should be ascribed to the Deity; but, if such was his opinion, he ought to have stated it distinctly and broadly; which he certainly would have done had he felt any anxiety to prevent misrepresentation. As it is, his God is an exact counterpart of the God of Epicurus, who leaving all to nature or chance, takes no further care or thought for the worlds to which he had given being.

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[1] *N. Dict. D'Hist. Nat.* xxii. Art. *Nature*, 364.

[2] *Ibid.* 369, 376.

But what is this mighty and next to omnipotent power,

> This great-grandmother of all creatures bred,
> Great Nature ever young, but full of eld;
> Still moving, yet immoved from her sted;
> Unseen of any, yet of all beheld;
> Thus sitting in her throne———

as quaintly sings our great bard of allegory.[1]

Now this great-grandmother of the whole creation, who, according to our author, takes all trouble off the hands of the God of Gods, sitting as it were in his throne, and directing and upholding all things by the word of her power,—what is she? Is she not at least a secondary spirit, co-extensive with the physical universe which she forms, and the limits of which alone terminate her action? This the various and wonderful operations attributed to her by this her worshipper would proclaim her to be. How then are we surprised and astonished when studying and weighing every scruple of his definitions of this his great Diana of Ephesus, and casting them up, we find at the foot of the account that she literally amounts to NOTHING. That she is a compound of attributes without any subsistence to hang them upon. His primary character of her, on which he insists in every part of his works, declares her to be an *Order of Things.* What idea does this phrase convey to the mind? That of things arranged and acting in a certain order. But no—this is not his meaning. She is an order of things composed of objects independent of matter. These objects are all metaphysical, and are neither beings, nor bodies, nor matter. But if she is not a *being*, she can have no existence. Yes, says our author, she is composed of *motion.* But what is motion considered abstractedly, without reference to the mover or the moved? Like its negative *rest*, it is

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[1] Faërie Queene, B. VII. c. vii. st. 13.

nothing. He, *Whose goings forth have been from of old, from everlasting*, is the First Mover, and the motion which he hath generated in his physical universe, was communicated by Him to existences, which he had created and formed to execute his will, and by them to others, and so propagated, as it were, from hand to hand, according to his laws, till the universe was in motion generally, and in all its systems and their several members. The Deity, at once the centre and circumference of creation, going forth incessantly, all the systems that form the physical universe, severally concatenated into one great system, responding to his action, and revolving round and contained in that central and circumferential fountain of ever-flowing light and glory,[1] that Spiritual Sun of the whole universe of systems, of which every sun of every system is a type and symbol. To Him be ascribed the Glory, and the Power, and the Kingdom, *in sæcula sæculorum*, Amen.

Another object which Lamarck considers as constituting nature, is *Law*. But law considered abstractedly is also nothing. It may exist in the Divine counsels, but till it is promulgated, and powers appointed and empowered who can enforce it; as likewise other objects brought into existence upon which it can act, or that can obey it; it is a word without power or effect. As in order to motion there must be a mover and something to be moved, so in order to a potential law, as well as a promulgator, there must be a being to enforce it and another to obey it.

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[1] Deus omnium capax, Herm. *Pastor*, l. ii. Mand. 1. Iren. *Adv. Hæres.* l. ii. c. 55.

With regard to his third ingredient, *space* and *time*, the theatre and limit of Nature's operations; they give her no subsistence, she still remains a nonentity; therefore, as defined by our author, she is *nothing*, and can *do* nothing.

But although nature, as defined by Lamarck, consists merely of abstract qualities, independent of any essence or being, and therefore can neither form any thing, nor operate upon what is already formed; yet would I by no means be understood as contending that there are no *inter-agents* between God and the visible material world by which he acts upon it, and as it were takes hold of it; by which he has commenced and still maintains motion in it and its parts; causing it to observe certain general and local laws; and upholds, in the whole and every part, those several powers and operations that have been thus produced; that action and counteraction every where observable, by which all things are maintained in their places; observe their regular motions and revolutions; and exhibit all those phenomena that are produced under certain circumstances. Whatever names philosophers have used to designate such powers, they have a real substance and being, and are a something that can act and operate, and impart a momentum.

Lord Verulam's two *hands* of nature, whereby she chiefly worketh,[1] *heat* and *cold*, synonymous, according to some, with positive and negative electricity;[2] the *plastic nature* of Cudworth, and some of the ancients; the *spirit of nature* of Dr. Henry More;[3] and the *ether* of Sir Isaac Newton, all seem to express or imply an agency between the Deity and the visible world, directed by him. *At-*

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[1] Bacon's Works, iii. *Nat. Hist.* Cent. i. p. 69.

[2] See *Lit. Gaz.* January 7, 1835, p. 43.

[3] See Vol. II. p. 254.

traction and *repulsion ; centripetal* and *centrifugal forces*, or *universal gravitation*, all imply a power or powers in action, that are something more than names and nonentities, that are moving in two directions, and consist of antagonist forces.

If we consult Holy Scripture with the view of ascertaining whether any or what terms are therein employed to express the same powers, we shall find that generally speaking, the word heaven, or the heavens, and symbolically the cherubim, are used for that purpose. But upon this subject, which has considerable bearing upon the doctrine of instinct, I shall enlarge in a subsequent part of this introduction.

Having stated Lamarck's hypothesis with respect to nature, the Goddess which he worshipped, and which he decked with divine attributes and divine power, I shall, as briefly as possible, give some account of his theory of *life*. Life indeed is a subject that hath puzzled, doth puzzle, and will puzzle philosophers and physiologists, probably till time shall be no more. Thus much, however, may be predicated of it, that both in the vegetable and animal, like heat, it is a *radiant* principle, shewing itself by successive developements for a limited period, varying according to the species, when it begins to decline and finally is extinguished: that sometimes also, like heat, as in the seed of the vegetable and egg of the animal, it is latent, not manifesting itself by developement, till it is submitted to the action of imponderable fluids, conveyed by moisture or incubation.

But to return to our author. "We have seen," says he, "that the life which we remark in certain bodies, in some sort resembled nature, insomuch that it is not a being, but an order of things animated by movements; which has also its power, its faculties, and which exercises them necessarily while it exists.[1] He also ascribes these vital movements to an existing cause. Speaking of the imponderable incoercible fluids, and specifying heat, electricity, the magnetic fluid, &c. to which he is inclined to add light, he says, it is certain that without them, or certain of them, the phenomenon of life could not be produced in any body.[2] Now, though heat, electricity, &c. are necessary to put the principle of life in motion, they evidently do not impart it. The seed of a vegetable, or the egg of a bird have each of them, if I may so speak, a *punctum saliens*, a radiating principle, which, under certain circumstances, they can retain in a latent state, for a considerable time; but if once that principle is extinct, no application of heat, or electricity, under any form, can revive it, so as to commence any developement of the germe it animated. Experiments have been made upon human bodies; and those of other animals, which, by the application of galvanism, after death, have exhibited various muscular movements, such as lifting the eye-lids, moving the arms and legs, &c. but though motions usually produced by the will acting by the nerves upon the muscles have thus been generated by a species of the electric fluid, proving its affinity with the nervous power or fluid, yet the subjects of the experiment, when the action was intermitted, continued still without life; no return of that power or essence which was fled for ever, being effected by it, which seems to render it clear that neither caloric nor electricity, though essential concomitants of life, form its essence.

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[1] *Anim. sans Vertèbr.* i. 321.

[2] *Ibid.* i. 43.

I trust I may render some service to the cause of truth and science, if I again revert to the subject which I mentioned at the beginning of this introduction, I mean the study of the word of God, together with that of his works, with the view to illustrate one by the other.

The great and wonderful genius before alluded to, Lord Verulam, who laid the foundation upon which the proud structure of modern philosophy is erected, who banished from science the visionary theories of the speculator,[1] and the unfounded dogmas of the bigot, and made experiment, and, as it were, the anatomy of nature, the root of true physical knowledge; warns the philosopher against making holy scripture his text book, for a system of philosophy, which he says, is like seeking the dead amongst the living.[2] I am disposed, however, to think that this illustrious philosopher, by this observation, did not mean to exclude all study of the word of God, with a view to discover what is therein delivered concerning physical subjects, for he himself speaks of the book of Job, as pregnant with the mysteries of natural philosophy;[1] but his object was to point out the evil effects of a superstitious and bigotted adherence to the *letter* of scripture, concerning which men were very liable to be mistaken, and of inattention to its *spirit*, which is averse to all persecution, so that persons of a philosophic mind might not be interrupted in their investigations of nature, by the clamours or menaces of mistaken men.

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[1] *Idola Specûs.*

[2] *De Augment. Sc.* l. ix. c. 1. § 3.

In the dark ages, anterior to the Reformation, superstition occupied the seat of true and rational religion. *Ye do err not knowing the Scriptures*, was an observation almost universally applicable. The armed hand of authority was lifted up against all such as endeavoured to interpret either Scripture or nature upon just and rational principles. Every such effort was rejected, was reprobated *ex cathedra*, and persecuted as a dangerous and pestilent heresy: thus every avenue to the discovery of truth, either in religion or science, was attempted to be closed. This evil spirit it was that proscribed the system of Copernicus, and, because it appeared contrary to the *letter* of Scripture, persecuted Galileo for affirming that the earth moved round the sun. Lord Verulam clearly saw the evil consequences that would result to the cause of true philosophy, if the sober study of nature, and all experimental research into the works of creation, were to be denounced as impious, because of some seeming discordance with the letter of Scripture, or because a narrow-minded theologian could not discern where the writers of the Bible adopted popular phraseology, in condescension to the innocent prejudices and uninformed understandings of those to whom they addressed themselves; and he therefore employed all the energy of his powerful mind to persuade the learned theologian, that for the discovery of physical truth we must have recourse to induction from experiment and soberly conducted investigation of physical phenomena, while for spiritual we should seek to draw living waters from the fountain of life contained in Scripture. The Bible was not intended to make us philosophers, but to make us wise unto salvation.

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[1] *Ubi supr.* l. ix. c. 1, § 47, ed. 1740.

But it does not follow, because we are to seek for religious truth principally in the Bible, that we can derive none from the study of natural objects; nor, on the contrary, because we are not to go to the Bible for a system of philosophy, that no philosophical truths are contained in it. The Scripture expressly declares that *the invisible things of God* may be understood by the things that are made—and if we may have recourse to the works of creation as well as to revelation to lead us to the knowledge of the Creator, we may, on the other hand, by parity of reason, without meriting any reprehension, inquire into what God has revealed in Scripture concerning the physical world and its phenomena. Lord Bacon himself observes, that Philosophy is given to Religion as a most faithful handmaid; since Religion declares the will of God, and Philosophy manifests his power,—and he applies to this our Saviour's reproof of the Jews. *Ye do err not knowing the Scriptures nor the power of God.* That is, ye have not endeavoured to know him by a right mode of studying either his word or his works. The study of both is necessary to the right understanding of either—we cannot rightly understand God's word without a knowledge of his *works*, and perpetual appeal is made to his works in his word; neither can we perfectly understand his works without the knowledge of his *word*.

The penetrating mind of Bacon clearly perceived, that if supposed statements of Scripture were made the sole test by which philosophical systems were to be tried, there was an end of all progress in science, no use in making experiments, or pursuing a course of inductive reasoning. And this was the temper of the age in which he lived; light was beginning to spring up, and because it was novel, it was thought to be heretical and subversive of Scripture. But men's minds are now much altered in this respect, and there is no danger of persecution on account of heterodoxy either in religion or philosophy. In fact the tide seems turned the other way, and a clamour is sometimes raised against persons who consult the revealed word of God on points connected with philosophy and science. But surely if the Scriptures are, as we believe, a revelation from the Creator of that world concerning which we philosophize, and if some parts of them do contain mysteries of natural philosophy, as Bacon himself contends they do, some respect and deference are due to the word of God, and some allowance may be claimed by those who appeal to it on any point of science, even if their appeal originates in a misconception and misinterpretation of any part of it; the same allowance as is made for those, and they are many, who misinterpret nature.

In the observations here made upon some dicta of the illustrious sage, who, unless we admit his venerable namesake, Friar Bacon, to a share in that distinction, may be termed the first founder of modern philosophy, I have not the most distant thought of detracting from the splendour of his merits, or of deducting any thing from the amount of the vast debt which science owes him; but, as I have before observed, mankind, from the earliest ages, have been prone almost to idolize those to whom they were indebted for any weighty benefits, or to whom they looked up as inventors of useful arts, or masters of hitherto occult sciences. Gratitude, indeed, demands that great and original geniuses, whom God has enriched with extraordinary talents, by the due exercise of which they have become benefactors of the human race, should be loved and valued highly for their services; but when we look only at the instrument, and see not the hand of Supreme Benevolence that employs it for our benefit, we then overvalue man and undervalue God; putting the former into the place of the latter, and making an idol of him; and if any will not worship this idol, a clamour is raised against them, and they are almost persecuted. Our great philosopher himself complains of this tendency to overvalue individuals as the cause and source of great evils to science: he considers it as a kind of fascination that bewitches mankind.[1]

Since the time of Bacon, philosophers and inquirers into nature have for the most strictly adhered to his rule, if such it may be deemed; and, with the exception of a single sect, who perhaps have gone too far in an opposite direction,[1] have made little or no inquiry as to what is delivered in Scripture on physical subjects, or with respect to the causes of the various phenomena exhibited in our system, or in the physical universe: but surely it is a most interesting, as well as novel field of study, for the philosopher to ascertain what has really been revealed in Scripture on these great subjects. The opinions of the ancients upon this head have been investigated and canvassed, and an approximation traced between them, in some respects, to those of modern philosophers:[2] if the same diligence was exercised upon the Scriptures, we might arrive at information with regard to the great powers that, under God, rule the physical universe, which it is hopeless to gain by the usual means of investigation.

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[1] Rursus vero homines a progressu in scientiis detinuit, et fere incantavit reverentia antiquitatis, et virorum, qui in philosophia magni habiti sunt, authoritas.———Itaque mirum non est, si fascina ista antiquitatis, et authorum, et consensus, hominum virtutem ita ligaverint, ut cum rebus ipsis consuescere (tanquam maleficiati) non potuerint. *Nov. Organ.* l. i. aphor. 84.

But the great difficulty lies in the interpretation of those passages of Scripture that relate to physical Phenomena. Bacon often repeats these words of Solomon,—*It is the glory of God to conceal a thing.* As Moses, when he descended from the mount, was obliged to veil his face, because the Israelites could not bear its effulgence;[1] so the Deity was pleased to conceal many both spiritual and physical truths under a veil of figures and allegory, because the prejudices, ignorance, and grossness of the bulk of the people could not bear them, but they were written for the instruction and admonition of those in every age whose minds are liberated from the misrule of prejudice, and less darkened by the clouds of ignorance: but still it requires, and always will require, much study and comparison of one part of Scripture with another, to discover the meaning of many of those passages of Scripture which relate to physical objects.

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[1] The Hutchinsonians.

[2] See Prof. Daubeny's *Introd. to the Atomic Theory*, 13.

The Apostle to the Hebrews observes that the manner in which God revealed himself to the ancient world and the Jewish nation, was by dividing his communications into many parcels, delivered at different times;[2] and by clothing them in a variety of figures, and imparting them under different circumstances,[3] so that in order to get a correct notion of them it is necessary to compare one part of scripture with another, and to weigh well the various figures under which they are concealed, and the use of them on other occasions; and also to consider the modes in which they were communicated to the mind of the prophet, whether in a vision exhibited to him when entranced; in a dream when asleep; or under certain acts, which he was commanded, or by immediate inspiration excited, to perform. So that if we wish to ascertain the meaning of any particular symbol, or of the terms in which any communication is made from God in Holy Scripture; we must not be satisfied by studying merely the passage under our eye, but, comparing spiritual things with spiritual, *hunt* out the meaning, as it were, by considering all those passages where the same thing is alluded to.

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[1] *Exod.* xxxiv. 29, &c.

[2] Πολυμερως.

[3] Πολυτροπως.

It is to be observed, that in all the communications which it has pleased the Deity to make of his will to mankind, respect is had to the then state of society, and the progress of knowledge, arts, and civilization —light was imparted to them as they were able to bear it; they were fed with milk when they could not digest strong meat.

Prejudices take usually so firm a hold upon the bulk of any people, that to attack them directly, instead of opening, closes all the avenues to the heart. Even the most enlightened in some respects, in others are often under their dominion; and, therefore, it is only by imparting truth *Here a little and there a little*, as circumstances admit, and embroidering the veil, under which we are obliged to soften the effulgence of her light, with varied imagery, darkly shadowing out her mysteries, that a way is prepared for her final triumph and universal reception. She is often *A light shining in a dark place*, gradually expelling prejudice and error, and *shining more and more unto the perfect day*.

It was not so much necessary for the conversion and reformation of mankind to make them *philosophers* as to make them *believers*. The great bulk of mankind were ignorant and uninstructed persons, whence in order to win their attention, it was necessary to address them in a language which they understood, and in a phraseology, with respect to physical objects, to which they were accustomed, and as those objects appear to the senses. Thus the moon is called a *great* light, because she appears so and is so to us, though really less than the planets and fixed stars; the sun is said to *rise*, and other parallel expressions, which are true with respect to us, and to the appearance of the thing, though not with respect to the fact physically considered. When the sacred writers speak of the Deity in terms borrowed from the human figure, as if he had hands, eyes, feet, and the like, and as if he was agitated by human passions, it is for the sake of illustrating the Divine attributes and proceedings by those passions, faculties, senses, and organs in man, by which alone we can gain any idea of what may be analogous to them in the Divine Nature.

But though such condescension is shown by the Holy Spirit to the ignorance and imperfections of his people, by adopting, as it were, a phraseology founded upon their innocent errors, and those misapprehensions of things into which they were led by their senses: it is not thence to be concluded that this popular language pervades the whole of the Holy Word; or that it is impossible, or even difficult, to distinguish things spoken *ad captum*, from statements relating to the physical constitution of nature which are to be received as spoken *ex cathedra*, and as dictated by the Holy Spirit. It should not be lost sight of, that the great object of Revelation was to reclaim mankind from the debasing worship of those that were not gods by nature; of those powers in nature, or their symbols, selected from natural objects, which God employed and directed as his agents in the formation and government of the globe we inhabit, and of the whole universe. "But we," says Bacon, "dedicate or erect no capitol or pyramid to the pride of men; but, in the human intellect, lay the foundations of a holy temple, an *exemplar of the world*."[1] This passage is capable of an application that may lead us into an avenue terminating in such a temple, which, though not erected *in* the human intellect, may enlighten it in several points relating to physical truths concerning which it is now in darkness. The Mosaical tabernacle and the Solomonian temple were both erected not after the imaginings of the spirit of man; but the former after a *pattern* which was shown to Moses in the mount;[2] and the latter after another given by David to Solomon, which it is expressly stated *he had by the Spirit*, and which *Jehovah made him understand in writing* (or commit to writing) *by his hand upon him.*[1] Now, if these holy places were erected after a pattern divinely furnished, that pattern doubtless was *significant*, and intended to answer some important purpose. The great end which the Deity had in view by the selection of the Israelitish nation, was to prevent all knowledge of himself, as the Creator and Governor of the world, from being totally obliterated from the minds of men, and to keep alive the expectation of the promised seed, who was to effect the great deliverance of mankind from the yoke and consequences of sin, and the dominion of Satan. Had it not been for this step, the worship of those powers and intermediate agents by which God acts upon the earth and the world at large, and produces all the phenomena observable in the physical universe; of their symbols; or of deified men and women, would have entirely superseded the worship of their Almighty Author, and the whole earth would have been so covered by this palpable darkness, that no glimpse of light would have been left to foster the hope and prove the germe of a future day of glory. The great object, therefore, of the Godhead being the assertion of his own supremacy, and to proclaim his own agency by the powers that are known to govern in nature, it was to be expected that a tabernacle or temple erected after a pattern furnished by the Deity would conspicuously do this.

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[1] *Nov. Org.* aphorism. 120.

[2] Exod. xxv. 40, xxvi. 30.

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[1] 1 Chron. xxviii. 12, 19.

But before I enter further into this mysterious subject, it will be proper to obviate an objection that may be alleged, viz. that it is incongruous and out of place to introduce, into a work like the present, any inquiry into the nature and contents of the Jewish temple, especially the meaning of those symbolical images placed in the Holy of Holies and called the *Cherubim*, but when it is further considered that these symbols are represented as winged *animals* with four faces, and that these faces are those of the kings and rulers, as it were, of the *animal kingdom*:—namely, the *ox*, the chief amongst cattle; the *lion*, the king of wild beasts; and the *eagle*, the ruler of the birds; and lastly, *Man*, who has *all things put under his feet,*—there seems to be no slight connection between the cherubim and the animal creation. If we regard the antitypes of these images as exclusively *metaphysical*, this argument will not hold; but if, as I hope to prove from Scripture, they consist of *physical* as well as metaphysical objects, by which the Deity acts upon the whole animal kingdom, and particularly in all *instinctive* operations, I trust I shall be justified in entering so fully into this interesting subject. In this inquiry I have endeavoured to guide myself entirely by the *word* of God, *comparing spiritual things with spiritual;* at the same time taking into consideration those arguments, where the case seemed to require it, that his *works* supply.

The Jewish tabernacle, which, as Philo calls it,[1] was a portable temple, every reader of Scripture knows was divided into two principal parts, or, according to the apostle to the Hebrews, *tabernacles;* the first of which was called the Holy Place; and the second, the Most Holy Place, or the Holy of Holies. This last tabernacle is expressly stated in Scripture to be a figure of heaven. "*For Christ is not entered into the holy places made with hands, which are the figures of the true, but into Heaven itself, now to appear in the presence of God for us.*"[1] Where allusion is evidently made to the annual entry of the Jewish high priest into the second tabernacle, as representing Christ's entry into heaven itself, where the presence of God was manifested. Now if the second tabernacle represented the Heaven of Heavens, the first we may conclude, in which the ordinary service and worship of God were transacted, was a symbol of this world or our solar system.[2]

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[1] Ἱερον φορητον. *De Vita Mosis,* l. iii.

If we consider the furniture of the two tabernacles, we gain further instruction on the subject we are considering. In the first was the golden candlestick with its seven lights, the table, and the shew-bread. Amongst the Jews, the candlestick seems to have been regarded as a kind of *planetarium*, representing the solar system, at least those parts of it that were visible to the unassisted eye.[1] It is worthy of remark that the central lamp, which appears to be four times the size of the rest, is stated by Philo to represent the *sun*. The table and the shew-bread, in a physical sense, may perhaps be regarded as symbolizing the earth and its productions, the table which God spreads and sets before us. But as well as a physical, these things have a metaphysical or spiritual meaning. The candlestick symbolizing the church and its ministers, who are characterized as "*Lights in the world*,"[2]—the churches as candlesticks, and the principal ministers of Christ as stars.[3]

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[1] Heb. ix. 24.

[2] ῾Αγιον κοσμικον.

The contents of the second Tabernacle, or Most Holy Place, are now to be considered; these were an ark or chest containing the two tables of the decalogue, over which was placed a propitiatory or mercy-seat of pure gold, at each end of which, and forming part of the same plate, was fixed a *Cherub*, or sculptured image so called. The directions for the fabrication of these images are not accompanied by any description of them. They are spoken of as objects well known to the Jews; but in the prophecy of Ezekiel, they are described as each having four faces and four wings; the faces were those of a man and a lion on the right side; the face of an ox on the left side; and the face of an eagle; with regard to their wings, two were stretched upwards, and two covered their bodies. Many other particulars are mentioned by the prophet, which I shall not here enlarge upon.[1]

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[1] Joseph. *Antiq.* l. iii. c. 7, comp. Philo *De Vita Mosis*, l. iii. 518, B. C. Ed. Col. All. 1613.

[2] Philip. ii. 15. Φωστηρες εν κοσμω.

[3] Revel. i. 20.

A great variety of opinions have been held, both in ancient and modern times, concerning the meaning of these symbols, and what they are designed to represent, some of which I shall mention in another place. By most modern theologians they seem to be regarded as *angels* of the highest rank. The first mention of them in Holy Scriptures is upon the occasion of the expulsion of our first parents from Paradise. "*And he drove out the man; and he* placed *at the east of the garden of Eden cherubims, and a flaming sword which turned every way,*

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[1] Ezek. i. 6, 10, 11.

to keep the way of the tree of life."[1] The word which in our translation is rendered *placed*, means properly *caused to dwell, or placed in a tabernacle,*[2] and it was on this account probably that in the Septuagint translation, the expression is referred to Adam. "*And he cast out Adam, and caused him to dwell opposite the garden of Eden. And he placed in order the cherubim, and the flaming sword which turned to keep the way of the tree of life.*"[3] The word in question is used by Jeremiah to denote God's presence in his tabernacle in Shiloh.[4] It may be remarked also that, in the original, the phrase is not simply that God placed cherubim at the east of the garden of Eden, but, as is evident from the particles prefixed to it, that he placed there *the* cherubim, namely such objects as were generally called by that name, and were familiar to the Jews. Had God given it in commission to angelic beings to keep watch and ward at the gate of Paradise, it would surely have been said upon this, as upon other occasions, that he *sent* them. When we reflect that these mystic beings, when only sculptured images, were symbols of the divine presence, and that God manifested himself in his tabernacle and in his temple by a cloud and glory when the work was finished according to the pattern, and the cherubim with the ark and mercy-seat were in their places,[1] surely some suspicion must enter our minds that these cherubim, before the gates of Paradise, might be stationed there for purposes connected with the worship of God after the fall. Indications of this are discoverable in other passages, as where it is said of Cain and Abel, that they *brought* an offering unto the Lord; a term implying that sacrifices were not offered in any place, according to the fancy of the worshipper. Again, after the murder and martyrdom of righteous Abel by his brother's hand, and the divine sentence passed upon the latter, he says, "*Behold, thou hast driven me out this day from the face of the earth, and from thy face shall I be hid.*"[2] And it is subsequently stated, "*And Cain went out from the presence of the Lord.*"[1] From these passages it seems to follow evidently that God was present, in some restricted sense, in one particular place, by departing from which Cain was hid from his *face*, whatever was intended by that expression. In this local sense, a temple or tabernacle dedicated to his worship, as prescribed by himself, might be called his *presence;* or in a still more peculiar sense, it might be so denominated, if in its sanctuary it contained any symbolical representation of God's universal dominion, and of his action every where; or if any cloud or irradiation of his glory was there manifested to his worshippers.[2]

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[1] Genes. iii. 24.

[2] Heb. ישכן

[3] Gr. *Και εξεβαλε τον Αδαμ, και κατωκισεν αυτον απεναντι τȣ παραδεισȣ της τρυφης. και εταξε τα χερȣβιμ, και την φλογινην ῥομφαιαν, την ϛρεφομενην φυλασσειν την ὁδον τȣ ξυλȣ της ζωης.*

[4] Jerem. vii. 12.

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[1] Exod. xl. 18—38. 2 Chron. v. 7—14.

[2] Genes. iv. 14.

With regard to the flaming sword, which our translation seems to put into the hands of the cherubic watch, and which Milton has so finely paraphrased:

> And on the east side of the garden place,
> Where entrance up from Eden easiest climbs,
> Cherubic watch, and of a sword the flame
> Wide-waving, all approach far off to fright
> And guard all passage to the tree of life.

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[1] Genes. iv. 16.

[2] Exod. xl. 34—38.

And again,

> They looking back all th' eastern side beheld
> Of Paradise so late their happy seat,
> Wav'd over by that flaming brand, the gate
> With dreadful faces throng'd, and fiery arms.

The words in the original may either be understood metaphorically of a flame like a sword, or it may be translated a consuming flame, a flame of burning heat; the original word[1] often signifying an exhausting and violent heat. The word which we translate *turned every way,*[2] is in Hithpael, and signifies an action upon itself; it is used in the same conjugation in other passages, where the sense seems to be that of revolving or rolling.[3] Ezekiel in his vision of the cherubim, describing the fire that preceded their appearance, says that it infolded itself.[4]

The last words of the passage in question, *to keep the way of the tree of life,* admit of two opposite interpretations—either to shut it up from all access, or to prevent it from being wholly closed. Perhaps the following interpretation—that the end for which the cherubim and flaming sword were placed at the east of the garden of Eden, was to close for ever the way to the *old* tree of life, and also to open the way to one better suited to man's altered circumstances and situation—will reconcile both interpretations. As soon as man was expelled from Paradise, the original covenant was ended, and he was cut off from all the means of grace and spiritual life that it held forth; and therefore it might be expected that his merciful and beneficent Creator would, in pursuance of the great scheme of salvation, through the promised seed of the woman, which he had thrown out to him as an anchor of hope, would supply him with other means suited to his fallen state, by which he might be renewed unto holiness, and gradually nourished in grace, so as at last to be prepared to undergo the sentence passed upon him with a prospect before him of entering into that rest that remaineth for the people of God.

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[1] Heb. חרב

[2] Heb. המתהפכת

[3] Judges vii. 13. Job. xxxvii. 12.

[4] Ezek. i. 4. Heb. אש מתלקחת

Having, I trust, not upon slight grounds, made it appear probable, that the cherubim, by the Deity himself, were placed in the original temple or tabernacle, and were intimately connected with that form of worship which was instituted by him in consequence of that sad event, the fall of man from his primeval state of holiness and happiness; I shall next endeavour to ascertain what these multiform images represented. But I must first premise a few observations upon the legitimate mode of collecting truths of this description from Holy Scripture, and I must here recall to the reader's recollection the observation of Solomon before quoted—*It is the glory of God to conceal a thing*. A number of important truths are delivered in Holy Writ, which are veiled truths, which we shall never discover if we adhere to the *letter*, and content ourselves with admiring the richness and beauty of the setting, without paying any attention to the gem it encircles or conceals. Some writers require a clear, distinct, and explicit statement, before they will admit any thing as revealed in Scripture, be the circumstantial evidence of the fact ever so strong. For instance some eminent theologians deny the Divine origin of *sacrifices*, because no command of God to Adam or Noah to offer them is recorded to have been given; yet one should think the practice of *righteous* Abel, and of Noah, *perfect in his generations*, and

God's acceptance of their respective sacrifices,[1] was a sufficient proof that this was no act of will-worship, but one of obedience to a Divine institution. The circumstance that God clothed Adam and Eve in the *skins* of *beasts*, proves that beasts had been slain, which were most probably offered up as victims representing the great atonement, the promised seed—and the clothing of them in their skins was an indication that they wanted garments, in the place of their own innocency and righteousness, to cover their nakedness, and that they now stood as clothed in the righteousness of Him whose heel was to be bruised for them. The distinction also of *clean* and *unclean* beasts directly sanctioned by the Deity, and which alone might be offered in sacrifice,[2] is another circumstance confirmative of the common opinion.

God, both in his word and in his works, for the exercise and improvement of the intellectual powers of his servants, and that—"*By reason of use they may have their senses exercised to discern both good and evil;*"[3] has rendered it indispensable that those who would understand them, and gain a correct idea of his plan in them, should collect and place in one point of view things that in Nature and Scripture are scattered over the whole surface, so that by comparing one part with another they may arrive at a sound conclusion. Hence it happens that, in Scripture, when any truth is first to be brought forward, it is not by directly and fully enunciating and defining it, so that *he who runs may read* and comprehend it, but it is only incidentally alluded to, or some circumstance narrated which, if duly weighed and traced to its legitimate consequences, puts the attentive student in possession of it. Such notices are often resumed, and further expanded, in subsequent parts of the sacred volume, and sometimes we are left to collect that an event has happened, or an institution delivered to the patriarchal race, without its being distinctly recorded, from circumstances which necessarily or strongly imply it. In a trial in a court of justice it very commonly happens that no direct proof of an event can be produced, and yet the body of circumstantial evidence is so concatenated and satisfactory as to leave no doubt upon the minds of the jury as to the nature of the verdict they ought to deliver. It would be a great and irreparable loss to the devout and sober student of Holy Scripture, if in his endeavours to become acquainted with the different parts of it, he is to be precluded from forming an opinion as to certain events and doctrines, because it has pleased the Wisdom of God to record and reveal them not directly and at once, but indirectly, in many parcels, and under various forms.

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[1] Genes. iv. 4. viii. 20, 21.

[2] Ibid. and vii. 2, 3.

[3] Heb. v. 14.

To apply this reasoning to the subject I am discussing. Having rendered it probable that the cherubim placed in a tabernacle at the east of the Garden of Eden, represented the same objects, and were so far synonymous, with those afterwards placed in the Jewish Tabernacle in the most holy place overshadowing the mercy-seat, and that the Divine Presence was more particularly to be regarded as taking there its constant station, and there occasionally manifesting itself by a cloud and a fiery splendor, I shall next endeavour to show what the cherubic images really symbolized.

The word Cherub, in the Hebrew language, has no root; for the derivation of it from a particle of similitude and a word signifying the mighty or strong ones, which is proposed by Parkhurst and the followers of Mr. Hutchinson, seems to me not satisfactory. Archbishop Newcome[1] and others derive it from a Chaldee root, which signifies to plough, and the radical idea seems to be that of *strength* and *power*, which will agree with the nature of the derivative, as indicating the powers, whether physical or metaphysical, that *rule* under God. Other divines, as God is said to *ride* upon the cherubim, and they are called his *chariot*, would derive the word, by transposition, from a root which signifies to ride;[2] but if a transposition of the letters of the word may be admitted, I should prefer deriving it from a root which signifies to *bless* or to *curse*,[3] since, as we shall see, the cherubim are instruments of good or evil, according as God sees fit to employ them; fruitful seasons and every earthly blessing being brought about by their ministry.

The word *Cherub*, pl. cherubim, considered as derived from any of the roots last mentioned, conveys therefore the idea of *strength* and *power;* of God's action upon and by them, expressed by his *riding* or *sitting* upon them, and *inhabiting* them; as likewise by his employing them as instruments both of good or evil, of *blessing* and *cursing.*

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[1] Newc. *Ezek*. c. i. 10, note.

[2] רכב

[3] ברך

That the cherubim are *powers* or *rulers* in nature is evident, as was before observed, from their symbols—the man, the lion, the ox, and the eagle. It is singular that amongst the descendants of the three sons of Noah, the three last animals should be adopted into their religion,—the *ox,* the Egyptian Apis, by the descendants of *Ham;*[1] the *lion,* as a symbol of light, by the Persians,[2] derived from *Shem;* and the *eagle* by the Greeks and other nations descended from *Japhet.*[3]

These powers, be they what they may, are described in Scripture as forming a *chariot* on which the Deity is represented as riding, and sometimes in such terms as bring to our mind, to compare great things with small, the chariots and charioteering of mortals. Thus we are told of *The chariot of the cherubim that spread out their wings, and covered the ark of the covenant of the Lord.*[1] And in Ezekiel's mystic visions, the glory of Jehovah sometimes went up from the cherubic chariot to the temple, when *The house was filled with the cloud, and the court was full of the brightness of the Lord's glory.*[2] And again, the glory of the Lord departs from the house, and stands over the cherubim, when mounting on high from the earth, *The glory of the God of Israel was over them above.*[3] A common epithet of God, as king of Israel, was that of Insessor of the cherubim,[4] *Whose name is called by the name of the Lord God of Hosts that dwelleth* between *the cherubim;* or he that sitteth upon, above, or between the cherubim; or, as it may be rendered, *Inhabiteth the cherubim.* These expressions allude, not only to the presence of God in his tabernacle and temple between or above the sculptured and symbolical cherubim, but to his riding upon, sitting upon, or inhabiting, that is ruling and directing those powers of whatever description, which are symbolized by those images, or signified by that name.

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[1] Other descendants of Ham, as the Phœnicians, regarded the ox or heifer as a sacred animal. Baal was worshipped as an ox as well as a fly. (Tobit, i. 5.)

[2] Mithras is to be seen with the head of a *lion* and the body of a man, having four wings, two of which are extended towards the sky, and the other two towards the ground. *Montfaucon,* i. 232. Comp. *Ezek.* i. 11.

[3] Every one knows that the eagle was sacred to the Grecian Jupiter.

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[1] 1 *Chron.* xxviii. 18.

[2] *Ezek.* x. 4.

[3] *Ibid.* 19.

[4] 1 *Sam.* xiv. 4. 2 *Sam.* vi. 2. 2 *Kings*, xix. 15. *Ps.* lxxx. 1. xcix. 1, &c.

When the Lord came to deliver David from his enemies, it is stated that he rode upon a *cherub*;[1] and the prophet Habakkuk, alluding probably to the delivery of the Israelites by the destruction of the Egyptians in the Red Sea, exclaims, *Thou didst walk through the sea with thine* horses, *through the heap of great waters*;[2] and again, with a prospective view before him, perhaps, of some still mightier deliverance of the church from her enemies, "*Was the Lord displeased against the rivers? was thine anger against the rivers? Was thy wrath against the sea, that thou didst* ride *upon thy* horses *and upon thy* chariots *of salvation?*"[3] He uses the same instruments when his will is to inflict a *curse* and execute *judgments. The Lord will come with fire, and* with his chariots *like*

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[1] 2 *Sam.* xxii. 11. *Ps.* xviii. 10.

[2] *Habak.* iii. 15.

[3] *Ibid.* 8.

a whirlwind, to render his anger with fury and to rebuke with flames of fire.[1] In Ezekiel's vision, coals of fire were taken from between the cherubim to scatter over Jerusalem.[2]

Having noticed the ideal meaning of these mystic symbols, and their connection with and subservience to Jehovah of Hosts, as the God of Israel, of Israel both according to the flesh and the spirit;[3] our next inquiry must be whether there are no physical or metaphysical beings or objects, concerning which the same things are predicated in Holy Scripture, as concerning the cherubim; for if there are, as equals of the same are equal to one another, it follows that these things must be synonymous.

Every student of Holy Writ, when he turns his attention to this observation, will immediately recollect passages in which the same things are predicated of the *heavens;* thus it is said of God, as the God of Israel—*Who rideth upon the* heavens *in thy help, and in his excellency upon the sky.*[4] And again,

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[1] *Isai.* lxvi. 16.

[2] *Ezek.* x. 2.

[3] 1 *Cor.* x. 18.

[4] *Deut.* xxxiii. 26.

Extol him that rideth upon the heavens.[1] *Him that rideth upon the* heaven of heavens *that were of old.*[2] Every one knows that, in Holy Scripture, God is also perpetually described as he who *sitteth* upon the *heavens;*[3] that the *heaven* is God's *throne*, and the *earth* his *footstool;*[4] that *The Lord hath prepared his* throne *in the* heavens;[5] that he dwelleth in the heavens, though they cannot contain him;[6] that he filleth heaven and earth.[7]

With regard to *Blessings* and *Curses*, that the *Heavens* are the primary instruments by which God bestows the one and inflicts the other, is evident from many passages of Holy Writ. Thus it is said in Deuteronomy,[8] *The Lord shall open unto thee* his good treasure the heavens,[9] *to give the rain unto thy land in his season, and to* bless *all the work of thine hand.* The prophet Hosea has a passage, in which the hands by which blessings and fertility are transmitted to man step by step are strikingly described. *And it shall come to pass in that day, I will hear, saith* the Lord, *I will hear* the heavens, *and they shall hear the* earth, *and the earth shall hear the* corn and the wine and the oil; *and they shall hear* Jezreel.[1] Thus the blessing descends from God by the heavens to the earth, producing abundance for the support and comfort of man. And with respect to *curses* it is said, *The* heaven *that is over thee shall be brass.*[2] *Ye are* cursed *with a* curse, saith Malachi, *for ye have robbed me, even this whole nation.* The *curse* alluded, was the shutting of the windows of *heaven.*[3]

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[1] *Ps.* lxviii. 4. [2] *Ibid.* 33.
[3] *Ibid.* ii. 4. [4] *Matth.* v. 34, 35.
[5] *Ps.* ciii. 19.
[6] *Ibid.* cxxiii. 1. 1 *Kings*, viii. 27.
[7] *Jerem.* xxiii. 24. [8] *Deut.* xxviii. 12.
[9] Heb. את אוצרו הטוב את השמים

From all these passages, it is evident that the same things are predicated both of the *Heavens* and the *Cherubim*, and that, therefore, they are synonymous terms, and signify the same powers. But this leads to another inquiry. What are the *heavens?* This is a query which at first every one thinks he can answer, but yet when the term comes to be sifted, it will be found that few have any definite idea of its real meaning. Generally speaking, the expanse over our heads, and the bodies it contains, are understood by the word *Heavens;* but when analysed, it will be found chiefly to indicate powers in *action* contained in that expanse, and which act upon these bodies; powers that in the various systems of the universe have various centres dispersed throughout space, each having a local or partial action upon its own system, and all derived originally, and still maintained, from and by one parent fountain, the centre of all irradiation, of all light, of all life and energy.

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[1] *Hos.* ii. 21, 22.
[2] *Ibid.* xxvii. 23.
[3] *Malach.* iii. 9, 10.

In order to ascertain what the word heaven, or heavens, really means, the most satisfactory way is to submit it to analysis. In the Bible there are *three* terms employed to signify the heavens and heavenly powers, one of which[1] is usually rendered the *Heavens;* another,[2] the *Sky;* and a third,[3] the *Firmament.* I shall consider each of these terms.

1. *Heaven, or the heavens.*—This word, in the Hebrew language, is derived from a root,[4] which signifies to *dispose* or *place,* with skill, care, and order, as say the lexicographers; so that literally the common plural term would be

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[1] שמים [2] שחקים [3] רקיע [4] שם

the *disposers* or *placers.* It is singular, and worthy of particular notice, that the Pelasgians, according to Herodotus, gave no other names to their deities than that of *gods,*[1] so calling them because they were the *placers*[2] of all things in the world, and had the universal *distribution* of them.[3] We see here that the Grecian gods—which, as has been proved in another place,[4] were *subsequent* to the original chaotic state of the heavens and the earth when the one was without light, and the other *without form and void*—were really synonymous with those ruling physical powers which God employed as his instruments first in the formation of the heavenly bodies, and next in that of their organized appariture, whether vegetable or animal; and lastly, in maintaining those motions or revolutions in the bodies just named, which he had produced, and other physical phenomena which were necessary for the welfare of the whole system and its several parts. These powers, whatever name we call them by,[5] form the *disposers* or *placers*, the

[1] Θεοι. [2] θεντες.

[3] Θεȣς δε προσωνομασαν σφεας απο τȣ τοιουτȣ, ὁτι κοσμω θεντες τα παντα πρηγματα και πασας νομας ειχον. Euterp. c. 52.

[4] See Appendix, Note 1. [5] See above, p. xxxix.

heavens in action: these are the Jupiter, Juno, and Minerva of the Greeks and Romans, and the various deities of other nations: *For all gods of the nations are idols,* saith the Psalmist,[1] *but Jehovah made the heavens,* or the powers symbolized by the idols of the nations. These are those powers which, under God—who, as the charioteer of the universe, directs them in all their operations, whether in heaven or on earth, to answer the purposes of his providence—execute the laws that have received his sanction. These are the physical cherubim represented by the earthly rulers—the man, the lion, the ox, and the eagle—these the chariot and throne of the Deity; the hands also by which he taketh hold of material things; the feet by which he treads on the earth and other planets.

Those sublime metaphors of the prophet Nahum—*Jehovah hath his way in the whirlwind, and in the storm and the clouds are the dust of his feet*[2]—though at first sight appearing only magnificent figures, when analysed will be found literally true. *Knowest thou the ordinances of the heaven? canst thou set the do-*

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[1] *Ps.* xcvi. 5.

[2] *Nahum,* i. 3.

minion thereof in the earth?[1] saith God; showing that he, by his instruments the heavens, rules the earth: this is said in stronger terms, when the heaven is declared to be God's throne, and the earth his footstool, which implies that God acts upon the earth by what are called symbolically his feet—those powers therefore that produce whirlwinds and storms in our atmosphere; that by their impact upon our planet cause evaporation, and consequently form the clouds, are the metaphorical feet of Jehovah, so that the clouds with strict propriety may be called the dust excited by the tread of his feet. When the Psalmist says of God, *He sitteth upon the cherubim, let the earth be moved*, what beauty, propriety, and force is there in the expression when it is recollected that the physical cherubim are those powers that have complete dominion over the earth, and cause its motions.

2. The *Sky*.—The word we render by the term *sky*, or skies, for it is always used in the plural, is derived from a root,[2] which signifies to *comminute*, grind, or wear by friction, implying powers that come in contact from oppo-

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[1] *Job*, xxxviii. 33.

[2] שחק

site directions, so as to be antagonist or conflicting powers. The cherubim placed at each end of the mercy seat had their faces inward, or looking towards each other,[1] so that they appeared to symbolize antagonist powers, as if one was a *vis centrifuga*, and the other a *vis centripeta*. *The pillars of the earth are the Lord's, and he hath set the world upon them ;*[2] and these two antagonist forces, that which flies from and that which seeks the centre, form that, so called, universal gravitation, which, under God, upholds the universe, keeps all its wholes and their parts in their places, maintains their motions, and mutual actions upon each other. But though these, as moving in an opposite direction, may be called antagonist or conflicting powers, yet their opposition is not enmity, but universal harmony and love. This Philo seems to intimate, when he says—a station,[3] over against Paradise, was assigned to the cherubim, and the flaming sword, not as to enemies about to struggle and fight, but as to those that were most intimate and friendly. It is said of the cherubic animals, in Ezekiel, that they *ran*

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[1] *Exod.* xxxvii. 8. 9.

[2] 1 *Sam.* ii. 8.

[3] *De Cherubim.* 85. F. G. Ed. Col. Allobr. 1643.

and returned as the appearance of a flash of lightning,[1] which seems to intimate a constant efflux and influx of inconceivable rapidity. Accordingly the effluxes of light and heat from the solar orb in our own system are never intermitted, and their velocity, for that of light has been measured, exceeds that of any other moving substance. With respect to the fuel, if I may so express myself, that maintains this constant expenditure, little seems yet to be known of it philosophically; and we can only form conjectures with respect to it derived from the general analogy of nature, as far as it is submitted to the observation of our senses. On earth we know that there can be no combustion or evolution of light and heat without the access of *air* to an ignited body; and that a constant supply of some *combustible* substance to replace the constant expenditure of fuel is also necessary. Therefore, reasoning from analogy, something similar must take place at the great focus of light and heat. There must be an influx of air and a supply of combustible matter. That there is such an influx is rendered further probable by other analogical arguments. In man, who is called a *microcosm*, or world in miniature, there is as incessant a return of the blood to the heart in a negative state by one set of vessels, as there is an issue of it in a positive state by another. The lungs also inspire the air in one state, and expire it in another: and by this alternate flux and reflux life is maintained; but suspend it beyond a certain period and death is the result. Again, the rivers are constantly discharging their waters into the sea by one channel and receiving them back again by another. Plants likewise, and animals, derive their nutriment from the earth and from the heavens, and under other forms return it again to the sources from which it flowed. So that it seems to be a general law that where there is an efflux there must also be an influx.

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[1] *Ezek.* i. 14.

3. The *Firmament.*—The proper translation of the word, which our version, after the septuagint, renders *firmament*, is—the *expansion. And God said, Let there be an* expansion, *and let it divide the waters,* &c. The cause of expansion is *heat,* which naturally divides and separates that in which it acts; as we see in the case of evaporation and the ascent of steam: and not only this, but the

expansive force consolidates that whereon its impact is, whence our translation renders the word, after the Greek, ϛερεωμα, the *firmament*, that which renders all things *firm*, the action of which produces the cohesion of the atoms of bodies, and their agglomeration round a partial or general centre: in this last acceptation it is synonymous with the term *attraction*, and in the former with that of *repulsion*. From these considerations we may readily understand why the Psalmist calls it, *The Firmament of his power or strength*.[1]

The terms *expansion*, then, and *firmament*, express the matter of the heavens in a state of action, going from or returning to its central fountain; for every system, as well as its own sun and planets, has doubtless its own heavens, probably never stagnant, but incessantly issuing from a centre of irradiation, as the blood from the heart in a positive state, and returning in a negative state to that centre where it is, as it were, again oxygenated, and circulates to the *flammantia mœnia mundi;* and so

Labitur, et labetur in omne volubilis ævum.

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[1] *Ps.* cl. 1.

But though every system probably forms a distinct portion of creation, yet, reasoning from analogy, and the general plan of the Deity, as far as we are acquainted with it, there is every reason to believe that the universe consists of systems so *concatenated* as to form one great whole, the centre of which may be the Heaven of Heavens, the presence-chamber of the God of Gods and Lord of Lords; in whom and from whom is all motion, light, and expansion. What may be the links that connect the several systems can only be conjectured. It has been observed with regard to *comets*, that *they wander from one solar system to another*;[1] if this be the case they evidently belong to *two* systems, and their perihelion in one, will be their aphelion in another, and thus they may form connecting links between them. This concatenation of systems may also have a common motion round their glorious centre, forming the grand cycle, or year, of the Universe.

Having, I trust, made it evident, or at least extremely probable, that the Heavens and the Cherubim, physically considered, indicate the same powers, I shall next advert to some passages of Scripture that seem to lift up the veil which covers these mysterious symbols, and show us expressly what they represent.

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[1] La Place, *System.* &c. by Harte, ii. 337.

In that sublime description of the descent of the Deity for the help and deliverance of David in the eighteenth Psalm, we have these words; *He rode upon a* Cherub *and did fly; yea, he did fly upon the* wings *of the* wind. Here we have one of these symbolical beings introduced and explained—as the latter hemistich of the verse is clearly exegetical of the former—by the phrase, *The wings of the wind.*[1] If we next turn to the hundred-and-fourth Psalm, in a parallel passage, we find an explanation of this latter metaphor. *He maketh the* clouds *his chariot, and walketh upon the* wings *of the* wind. Whence it appears that the *wings of the wind*, by an elegant metonomy, mean the *clouds*, consequently the clouds are a cherub. In various parts of the Old Testament, God's presence and glory are manifested by and in a *cloud.*

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[1] Parkhurst renders these words, *The wings of the Spirit*, but he stands alone in this.

When he led his hosts from Egypt through the Red Sea, he went before them by day in a pillar of a *cloud*, and by night in a pillar of fire;[1] when he was about to descend upon Mount Sinai, he said—*Lo, I come unto thee in a thick* cloud.[2] When the tabernacle was set up in the wilderness, and the work was finished, *Then a* cloud *covered the tent of the congregation, and the* glory *of the* Lord *filled the tabernacle.*[3] When Solomon's Temple was built, and the ark brought into the oracle, and placed under the wings of the cherubim, and the priests were come forth, then *The* cloud *filled the house, so that the priests could not stand to minister because of the cloud: for the* glory *of the* Lord *had filled the house of the Lord.*[4] As God thus came of old in a cloud, and by it manifested his presence to his people and in his house; so likewise when he spoke to them, it was from a cloud, as in the passage above quoted—*Lo, I come to thee in a thick* cloud, *that thy people may hear when* I speak *with thee.* And again, *And a* cloud *covered the mount; and the* glory *of the* Lord *abode upon Mount*

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[1] *Exod.* xiii. 21.

[2] *Ibid.* xix. 9, 16. 1 *Kings*, viii. 12.

[3] *Exod.* xl. 33, 34.

[4] 1 *Kings*, viii. 6—11.

Sinai, and the cloud *covered it six days; and the seventh day he called unto Moses out of the midst of the* cloud.[1] And in another place, *And the Lord* descended in the cloud, *and stood with him there, and proclaimed the name of the Lord.*[2] *And the Lord came down in a* cloud, *and spake unto him, and took of the Spirit that was upon him, and gave it unto the seventy elders.*[3] And in the New Testament, at the Transfiguration, *Behold a bright* cloud *overshadowed them, and a* voice *out of the cloud.*[4] From these passages it appears to follow, that when the Deity thought proper to address his prophets or his people by *the voice of words*, it was from a *cloud*.

But not only did God descend to communicate with his people, and to reside as it were amongst them in a *cloud;* but when our Saviour went up into Heaven, it was upon a *cloud*, which Athanasius calls mounting the *cherubim;*[5] and when he comes again, it will be in the same manner, attended by his holy angels. When he is said, in the

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[1] *Exod.* xxiv. 15, 16.

[2] *Ibid.* xxxiv. 5.

[3] *Numb.* xi. 25.

[4] *Matth.* xvii. 5.

[5] *Opera*, ii. 3017, D.

Apocalypse, to ride upon a White Horse, and the armies which were in heaven to follow him upon white horses;[1] by these *white horses* are meant *white clouds,* as is evident from other passages of Holy Writ; as where it is said—*Behold, he cometh with* clouds.[2] Again, God's going to execute judgments upon any nation is sometimes represented by his riding upon a *cloud.* So when the prophet pronounces the burden of Egypt, his exordium is—*Behold, the Lord rideth upon a swift* cloud, *and shall come into Egypt.*

So immediate is God's action upon the clouds described to be in the Bible, that the thunder is called his voice, as in Job—*Hear attentively the noise of his* voice, *and the sound that goeth out of his* mouth. *He directeth it under the whole heaven, and his lightning unto the ends of the earth——God* thundereth *marvellously with his* voice:[3] and when he descended upon Mount Sinai, it was with mighty thunderings.[4] Considering the benefits and blessing that God confers upon mankind by the ministry of the *Cherub-clouds,* his horses and chariots of salvation, we need not wonder at the Psalmist's expression—*His strength is in the clouds.*[1] Acting by them, he causes it *to rain upon one city and not upon another.*[2] *Are there any,* says Jeremiah, *among the vanities of the Gentiles that can cause rain? or can the Heavens give showers? Art not thou He, O Lord our God.*[3]

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[1] *Revel.* xix. 11, 14.

[2] *Ibid.* i. 7, comp. *Dan.* vii. 13. *Rev.* xiv. 14. *Acts,* i. 11.

[3] *Job,* xxxvii. 2—5.

[4] *Exod.* ix. 28.

The Deity superintends his whole creation, not only supporting the system that he has established, and seeing that the powers to which he has given it in charge to govern under him, execute his physical laws; but himself, where he sees fit, in particular instances dispensing with these laws: restraining the clouds, in one instance, from shedding their treasures; and in another, permitting them to descend in blessings. Acting every where upon the atmosphere, and those secondary powers that produce atmospheric phenomena, as circumstances connected with his moral government require. Thus it is that *his strength is in the clouds;* that his presence, either to bless or to curse, is manifested by them; that his voice is heard from them; his glory irradiates from them. On this account also they are called his *paths*.[1]

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[1] *Ps.* lxviii. 34.

[2] *Amos,* iv. 7.

[3] *Jerem.* xiv. 22.

The Lord is said to come with *fire*, or rather in fire;[2] to descend in fire;[3] to be a consuming fire;[4] to speak out of the fire;[5] from all which passages it seems to follow, that *fire* or heat form also one of the physical cherubim upon which the Deity sitteth, or which he inhabiteth, and by which he acteth.

Light appears entitled to the same distinction; for God is said to dwell in the light that no man can approach unto,[6] and to cover himself with light as with a garment.[7]

Lastly, *air* or *wind*, which God bringeth out of his treasury; which is the type, and, on the day of Pentecost, was the precursor of the Holy Spirit, both in Hebrew and Greek[8] is expressed by the same word distinguished only by its adjuncts; and is one of the main instruments by which God acts upon our globe, both in dispensing blessings and curses, and without which our life could not be sustained a moment, is evidently a *cherub*, or ruling physical power, of the same rank with heat and light.

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[1] *Ps.* lxv. 14.

[2] *Isai.* lxvi. 15. Heb. באש, the Septuagint seem to have read כאש.

[3] *Exod.* xix. 18.

[4] *Deut.* iv. 24.

[5] *Ibid.* 36.

[6] 1 *Tim.* vi. 16.

[7] *Ps.* civ. 2.

[8] רוח πνευμα.

The statement I have here given of the physical cherubim, is singularly confirmed in Ezekiel's vision. *I looked*, says he, *and behold a* whirlwind *came out of the north, a great* cloud, *and a* fire *infolding itself, and a* brightness *was about it.*[1] Here we see the appearance of the symbolical animals was preceded by that of the physical agents they symbolized—the *wind*, the *cloud*, the *fire*, and the *light*. The reason why the *clouds* are particularly signalized as God's chariots, appears to be because they are *instinct* with all those principles by which God acts upon the earth; and therefore they are described as carrying him, since they are the instruments by which his will has full accomplishment.

It is singular, and worthy of particular notice, that God is also said to dwell in *dark-*

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[1] *Ezek.* i. 4.

ness. The Lord hath said that he would dwell in the thick darkness;[1] and again—Moses drew near to the thick darkness where God was.[2] In the Psalms it is said—*He made* darkness *his secret* (or hiding) *place.*[3] Darkness was the state of the original heavens, before God formed the light, to which this passage seems to be an allusion. In Isaiah, the term *create* is applied to darkness, and *form* to the production of light;[4] from which it appears that it was out of darkness that light was formed; and these two opposites seem to bear the same relation to each other as positive and negative electricity, or heat and cold. Darkness was that in which the Divine Spirit operated, when by incubation motion, followed by light and expansion, was educed, and the sea brake forth from the crust of the earth as from the womb; when the cloud was the garment thereof, and thick darkness a swaddling band for it.[5]

In the different visions of the appearance of the Deity, as the Insessor of the chariot of the cherubim, it is stated, that expanded over their heads was a firmament like crystal or ice; that *above* this firmament was a sapphire throne; that one sat on this throne, round about whom was the appearance of a rainbow.[1] So likewise in the vision of the apostolic prophet, St. John—A throne was set in heaven, and one sat upon it, and there was a rainbow round about the throne, and before the throne was a sea of glass like unto crystal; and in the midst of the throne and round about the throne were four cherubic animals, which proclaim the *Trisagium.*[2] When Moses, Aaron and his sons, and the elders of Israel went up into Mount Sinai, and saw the God of Israel, He stood upon what was like a pavement of sapphire and as it were the body of heaven in its clearness.[3] In all these passages, the same idea seems to prevail with respect to the firmament—it is like ice or the terrible crystal in one—a sea of glass like crystal, or crystallizing, emitting the splendour of crystal in the other—like the body of heaven in its clearness in the third.

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[1] 2 *Chron.* vi. 1.

[2] *Exod.* xx. 21.

[3] *Ps.* xviii. 11.

[4] *Isai.* xlv. 7.

[5] *Job*, xxxviii. 8, 9.

The footstool of the Deity, the pavement on which his throne is placed, is over or above the heads of the cherubim; and though we cannot comprehend exactly the precise meaning of the figures employed, yet the general idea seems to be that of *irradiation;* and by these representations the claim of Jehovah the God of Israel is indicated to supremacy and entire dominion over the physical cherubim, or the heavens in a state of action, and as the sole fountain and centre of that incessant radiation and glory, and of those constant effluxes by which the whole universe of systems and worlds is maintained.

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[1] *Ezek.* i. 22, 26, 28.

[2] *Revel.* iv. 2, 3, 6, 7, 8.

[3] *Exod.* xxiv. 10.

It seems probable, therefore, that one of the principal reasons why the cherubic symbols were placed in the adytum of the Jewish tabernacle and temple was not only to represent those powers that govern under God in nature, but likewise to indicate his Supreme and only Godhead, and that his people were to beware of worshipping these powers or their symbols, because they derived so much benefit from their ministerial agency, but to worship Him alone who created them, employed them, and operated in and by them.

The ancients seem generally to have regarded the name and symbols as indicating and representing more than one object.

Philo Judæus, who has written a treatise upon those placed at the east of the garden of Eden, sometimes interprets them *physically*, and sometimes *metaphysically*. Physically, in one place, he considers one cherub as representing the sphere of the fixed stars, and the other that of the planets,[1] and in another he asks, whether they may not signify the two hemispheres,[2] both of which amount to the whole universe.[3] The flaming sword, he conjectures, either represents the general motion of the heavens and planets, or else is a symbol of the sun.[4] Metaphysically, he considers the two cherubim as symbolizing the Power and Goodness of the Deity, and the flaming sword the Logos or his essential Word; and this interpretation he seems to think was divinely suggested to him.[5] Clement of Alexandria, in some degree, seems to incline to the opinions, on this subject, of his compatriot Philo, but he expresses himself obscurely,[6] and, after alluding to other interpretations, concludes with mentioning "*The*

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[1] *De Cherubim.* 1613. 86. A. B.

[2] *Ibid.* D.

[3] *Ibid.* 85. G.

[4] *Ibid.* D. E.

[5] *Ibid.* 86. F. G.

[6] Clem. Alex. *Stromata.* l. v. 241. ed. Sylburg. 1592.

doxologising spirits whom the cherubim symbolize."[1] Irenæus, the learned Bishop of Lyons, who had conversed with Polycarp, St. John's disciple, regards these mystic objects as physical and ecclesiastical symbols, taking chiefly into consideration their *number*. The *four* quarters of the globe, the *four* winds, the *four* gospels, the *four* universal covenants given to man—each of these he appears to regard as figured by the cherubic animals;[2] and he might have added the *four* physical cherubim, spirit or wind, light, expansion, and the clouds. Justin Martyr has a singular opinion on this subject. He thinks Ezekiel's cherubim symbolized Nebuchadnezzar when he was driven out from the society of man as a beast:[3] when, according to the Septuagint which Justin used, he eat grass like an *ox*, his hair was like a *lion's*, and his nails like a bird's or *eagle's*. Athanasius has a remarkable passage, before alluded to, in which he says of Christ, that when he appeared upon earth, *He bowed the heavens and came down*, and that he again mounted the cherubim, and ascended into heaven,[1] from whence it should seem that he had adopted the opinion, that the heavens, and the clouds were antitypes of the symbolical cherubim: yet in another passage of his works, he expressly places the seraphim and cherubim amongst the highest of the heavenly essences. "As we know," says he, "that there is a distinction of rank in the powers above, so there are also differences of station and knowledge. The *thrones*, both the *Seraphim* and the *Cherubim*, learn from God immediately, as higher than all and nearest to God, and they instruct the inferior orders—but the lowest rank are the *angels*, which are also the instructors of men."[2]

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[1] In allusion probably to *Isaiah* vi. 3, and *Revel.* iv. 8.

[2] *Adv. Hæres.* l. iii. c. 11.

[3] *Quæst. et Resp. ad Orthodox.* Quæst. xliv.

It seems evident from this statement of the opinions of both ancient Jews and Christians, that the sculptured Cherubim, in their opinion, represented *physical* as well as *metaphysical* objects; in fact, the most general interpretation seems to be—that those powers that rule under God, either in his physical universe, or which, with regard to our planet, have power in his church, or over his people; and also those *spiritual* essences that approach nearest to him, in the purity of their natures, are the antitype of the cherubic forms. St. Paul, describing the creation of all things by the Son of God, whether *visible* or *invisible*, mentions particularly *four* ruling powers in nature and grace—*Thrones, dominions, principalities*, and *powers.*[1] This may be *interpreted* of all rule and government both in heaven and upon earth; which is all derived from Christ, as King of Kings and Lord of Lords, to whom *All power is given in heaven and earth:*[2] who therefore is the Insessor of the cherubim, acting by all the powers that he hath created, whether physical or metaphysical, whether civil, ecclesiastical, or spiritual; for *He upholdeth all things by the word of his power.*[3]

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[1] *Quæst. ad Antioch.* cxxxvi.

[2] *De commun. essent.* ed. Paris, 1627, i. 238.

In the prophecy of Isaiah, and in the Apocalypse,[4] the six-winged beings called by the former *The seraphim*,[5] and by St. John

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[1] *Coloss.* i. 16.

[2] *Matth.* xxviii. 18.

[3] *Heb.* i. 3.

[4] *Isai.* vi. 3. *Rev.* iv. 8.

[5] Heb. שרפים This name, which literally may be rendered *burners*, *physically* would signify the heavens in the most intense state of action; they are stated to have *six* wings, the upper pair veiling their faces, the lower pair covering their feet, the intermediate pair being used for flight. See *Isai.* vi. 2.

living-creatures[1]—which by most ancient writers are thought to be synonymous with the *cherubim*—are represented as repeating the *Trisagium;* the latter says—*They rest not day and night, saying,* Holy, Holy, Holy, *Lord God Almighty.* This triple ascription of Holiness is thought by many to intimate a Trinity of Persons in the Godhead, and that the physical cherubim or seraphim symbolically represent that mystery. Archdeacon Sharp, and after him Archbishop Newcome,[2] have observed, that this opinion is inconsistent with these symbolical animals *falling down and worshipping the Lamb, and ascribing their redemption to him;* an objection which appears to me not to have been satisfactorily answered. It should, however, be taken into consideration that the cherubim are symbols not solely of *physical*, but of all *governing* powers; and that, therefore, in order to interpret rightly any act of theirs, the

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When our Saviour says of the *wind*—*Thou hearest the sound thereof, but canst not tell whence it cometh and whither it goeth;* may not the same thing be meant as by Isaiah's Description of the Seraphim?

[1] Gr. *Ζωα.*

[2] Sharp *On the Cherubim,* 305. Newcome's *Ezekiel,* i. 10, note.

circumstances attending upon it should be carefully examined. If we consider the passages in the Apocalypse here alluded to, we shall find that when praise is to be rendered to God as *Creator and Upholder of the universe,* they then are stated to proclaim his Triune Deity, by saying—*Holy, Holy, Holy, Lord God Almighty, which was, and is, and is to come.* This they do as the physical powers, under God, upholding the universe, especially as fire, light, and air; all of which, in passages of Scripture above noticed,[2] appear to represent the Three Persons of the Holy Trinity. But when they are introduced as representing the *governing Powers* of the universal *Church,* as they are when they fall down and worship the *Lamb,* the case is altered; for those they then represent are amongst the redeemed.

One of my objects in treating so much at large upon this mysterious subject, was to counteract that tendency, often observable in the writings of philosophers, to ascribe too much to the action of second causes, and the mechanism of the heavenly powers; as if

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[1] *Revel. ubi supr.*

[2] *See above,* p. xcii.

they were sufficient of themselves, and without the intervention of the First Cause, to do all in all, and keep the whole machine and all its parts together and at work. Instead of regarding Him as receding further and further from our observation,[1] my desire is to bring Him nearer and nearer to us, that we may see and acknowledge Him every where, as the main-spring of the universe, which animates, as it were, and upholds it in all its parts and motions—

> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent.

Maintaining his own laws by his own universal action upon and by his cherubim of glory. WITHOUT HIM THEY CAN DO NOTHING.

I cannot conclude this Introduction without returning my grateful acknowledgments to the Board of Curators of the Hunterian Museum, for their kind permission to have drawings taken of such subjects in that superb collection as might answer my purpose; and to Messrs. Clift and Owen, the conservator and assistant-conservator of the museum, for their readiness, on all occasions, to show and explain to me such articles under their care as I had occasion to inspect; to the friendly attentions of the latter gentleman I am particularly indebted, not only for his exertions to serve me in the museum, but for his valuable information on numerous scientific subjects, on which I had occasion to consult him, which his deep knowledge of comparative anatomy, and familiar acquaintance with the classification of the animal kingdom, enabled him to give me. To the gentlemen connected with the British Museum and that of the Zoological Society, I have to make similar acknowledgments for the kindness and information with which my inquiries on several subjects have uniformly been answered.

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[1] See above, p. xxii.

As the first volume of this work was printed before the publication of Dr. Roget's admirable Treatise, it will not be deemed wonderful that, in some instances, we have treated of the same subject. The history, habits, and instincts of animals, are so intimately connected with their physiological structure, especially their *external* anatomy, that it is scarcely possible, in order to prove the adaptation of means to an end, to treat satisfactorily of the former without occasional illustrations from the latter. After the doctor's work appeared, I removed many things of this kind from my MS., upon which he had enlarged. The moult of Crustaceans, however, seemed to me, and to every friend whom I consulted, so necessary to make the history of that Class complete, that, though mostly derived from the same source as that of my learned Co-nominee, I did not expunge it.

THE

HISTORY, HABITS, AND INSTINCTS OF ANIMALS.

CHAPTER I.

Creation of Animals.

IN no part of creation are the POWER, WISDOM, and GOODNESS, of its beneficent and almighty Author more signally conspicuous than in the various *animals* that inhabit and enliven our globe. The infinite diversity of their forms and organs; the nice adaptation of these to their several functions; the beauty and elegance of a large number of them; the singularity of others; the variety of their motions; their geographical distribution; but, above all, their preeminent utility to mankind, in every state and stage of life, render them objects of the deepest interest both to rich and poor, high and low, wise and unlearned, so that arguments in proof of these primary attributes of the Godhead, drawn from the habits, instincts, and other adjuncts of the animal creation, are likely to meet with more universal attention, to be more generally comprehended, to make a deeper and more lasting impression upon the mind, to direct the heart more fervently and devotedly to the maker and giver of these interesting beings, than those which are drawn from more abstruse sources, though really more elevated and sublime.

The history of the animal kingdom naturally commences with the *creation* of animals, and the great events preparatory to it, for when the ALMIGHTY CREATOR, in his wisdom, and by the word of his power, had first brought into being, and afterwards set in order, the heavens and the earth; had caused the latter to bring forth grass, and herb, and tree, and then had placed his sun in the former, that by constant irradiations of light and heat from that central fountain, the life,[1] and motion, which the FIRST MOVER had begun by the incubation of his Spirit, and which now manifested itself in the vegetable kingdom, might be maintained till it had run its destined course. When all things were thus prepared, his next care was to people and enliven the earth with a different and higher class of beings, in whom—to organization, and life, and growth, and reproductive powers,—might be added sensation and voluntary motion. Unpeopled by animals, the verdant earth in all its primitive and untarnished beauty, though inlaid with flowers exhibiting, in endless variety, every mixture and shade of colour that can glad the sight; though fanned by gales breathing Sabean odours, to gratify the scent; though tempting the appetite by delicious fruits of every flavour, still would be a scene without the breath of life. No motions would be seen but of the passing clouds, of the fluctuating waters, and the waving boughs; no voice heard but of the elements.

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[1] See Appendix, note 1.

Was a single pair placed in this paradise, though at first it would seem that there was gratification for every sense, and joy would possess the heart, and admiration fill the soul with pleasure; yet after the novelty of the spectacle had ceased, and the effect of its first impression was obliterated, a void would soon be felt, something more would seem wanting to animate the otherwise lovely scene; a longing would arise in the mind for some beings, varying in form and magnitude, furnished with organs that would enable them to traverse and enliven the lower regions of the atmosphere, others that might course over the earth's surface, and others that could win their easy way through its waters, so that all, by their numbers, and the variety of their motions, might exhibit a striking and interesting contrast to the fixed and unconscious vitality of the vegetable kingdom.

But it was not the will of the beneficent Creator to leave such a blank and blot in his creation; before he created man in his own image, and enthroned him king of the new-made world, he decreed that his dominion also should be an image of his own, over innumerable creatures of every form and grade, each in its place entrusted with a peculiar office and function, and furnished with organs adapted to its work, contributing to its own and the general welfare; so that all should operate, "though each in different sort and manner," to accomplish the great plan of an All-wise Providence.

What was the precise order of creation in the animal kingdom is no where clearly revealed in Holy Scripture; and we can only conjecture, since the most perfect animal, and he who alone belonged to the spiritual and invisible world by his soul, as well as by his body to the visible, was created the last, that the progress was from those that were at the foot of the scale to those that were at the summit. We are told, indeed, in general terms, that on the fifth day, at the divine bidding, the waters, hitherto barren and untenanted, produced abundantly "*the moving creature that hath life*," and *fowl* to traverse the firmament. In an instant, in obedience to that quickening word, by the operation of Almighty Power, and under the guidance of infinite Wisdom and Goodness, the boundless ocean with all its tributary streams became prolific, and brought forth by myriads, in endless and strange diversity, its destined offspring, beginning, perhaps, with the viewless animalcule or the senseless polype, half animal and half plant, and ending with the half fish and half quadruped, cetaceans, and their kindred monsters.[1] Nor was the Ocean prolific of aquatic animals alone, and those whose habitation was the restless world of waters, with all its streams, its caves, and its abysses, it also gave birth to all the winged and feathered tribes —from the brilliant humming bird to the mighty eagle and the giant vulture—that people and enliven the atmospheric sea, and make it the field of their excursions. The animals created on this day were destined to dwell or move, independent of the earth, in a fluid medium of greater or less tenuity, and for that purpose were fitted with appropriate and peculiar organs, in one case both for respiration and locomotion, in the other for locomotion only.

Again the word of power was spoken,—"*Let the earth bring forth*," and instantly the various tribes of quadrupeds issued from her teeming womb, varying infinitely in size, from the minute harvest-mouse[2] to the giant bulk of the elephant and hippopotamus; then also the earth-born reptiles, whether four-footed, six-footed, eight-footed, or many-footed, started into life, and connected the terrestrial tribes with those produced from the waters. In the majority of these, the fins of the fishes and cetaceans, and the wings of the birds, were replaced by legs best fitted for motion on the theatre on which they were to act their part, and to fulfil the will of their Creator.

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[1] See Appendix, note 2.

[2] *Mus messorius.*

The earth was now completely furnished and decorated to receive her destined king and master. The sun, the moon, and the stars were shedding their kindly influences upon her; she and her fellow planets had commenced their annual and diurnal revolutions; the plants and flowers, her first born progeny, had sprung out of her bosom, and covered her with verdure and beauty; and the fruit and forest trees flourishing in all their glory of leaf, blossom, and fruit, were ready to minister to the support, comfort, and enjoyment of their future lord: the sea, the air, the earth, were each filled with their appropriate inhabitants, and throughout the whole creation was beauty, and grace, and life, and motion, and joy, and jubilee. But still, in the midst of all this apparent glory and activity of vegetable and animal life in the new created world, there was not a single being endued with reason and understanding; one that could elevate its thought above the glorious and wonderful spectacle to the great Author of it, or acknowledge and adore its Creator.

Amidst this infinite variety of beings there was not a single one which to a material body added an immaterial immortal soul; so that there was still a great blank in creation. A wonderful and magnificent temple was reared, and shone in glory and beauty, but there was as yet no priest therein to offer up incense to the Deity to whom it was dedicated.

We are now, therefore, to consider the creation of him for whom this high office was reserved, who, as king and priest, was to render to the common Creator the praises due from all created things, and be the spokesman for all the inhabitants of this terrestrial globe.

The vast distance, on this account, intervening between man and the highest animals in the scale of being, appears evident from the different circumstances attending their creation. When they were brought into existence, the word was—"*Let the waters bring forth—Let the earth bring forth,*" from which it should seem that God did not act *immediately* in their creation, except by his agency on those powers that he had established as rulers in nature, and by which he ordinarily taketh hold, as it were, of the material universe. But when a being, combining the spiritual with the material world, is to be created, all the persons of the Godhead unite *immediately* in the work, and without the intervention of any other agent, "*Let* US *make man.*" He was therefore neither sea-born nor earth-born, as some ancient nations claimed to be, but born of God; though, as Christ moistened clay when he was about to exercise his creative power, in the re-forming of an eye;[1] so was the humid earth used in the creation of the body of man by his Maker, and when that wonderful machine, with its complex apparatus of organs, both external and internal, was finished; when a throne and presence chamber were prepared for the intellectual and spiritual, and governing part of his nature, and that wonder-working pulp the brain, with its silver spinal cord and infinitely divaricated threads, already fitted for the mastery of every motive organ, was in a state to transmit without obstruction, each flux and reflux of that subtile fluid, intermediate, as it were, between matter and spirit,[2] which so instantaneously conveys and causes the execution of the commands of the will by every external bodily organ; when the heart was ready to beat; the lungs to play; the blood to circulate; and every other system to start for the fulfilment of its prescribed errand. "*Then the Lord God breathed into his nostrils the breath of lives, and man became a living soul.*" He was now installed into his kingdom over the globe which he inhabited, and dominion was given him over the inhabitants of the water, of the air, and of the earth; and the divine image, in which he was to be created, was rendered complete.

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[1] John, ix. 6.

[2] See Appendix, note 3.

Now, the generations of the world were perfect and healthful, and God saw every thing that he had made, and behold it was very good. That is,—every individual essence, whether inanimate or animate, was fitted in every respect to answer the end of its creation, and perform its allotted part in contributing to the general welfare. The entire machine was now in action, every separate wheel was revolving, and the will of Him who contrived and fabricated it had full and uninterrupted accomplishment. The instincts of the whole circle of animals urged them, by an irresistible impulse, to fulfil their several functions; I mean those that were necessary to the then state of things: for if the instinct of the predaceous ones was not restrained, they would soon have annihilated the herbivorous ones, even if, as Lightfoot supposes, they were at first created by sevens.[1] They must, therefore, originally have eaten grass or straw like the ox, and neither injured nor destroyed their fellow-beasts of a more harmless character; this, indeed, appears clearly from the terms of the original grant, "*To every beast of the earth, and to every fowl of the air, and to every thing that creepeth upon*

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[1] See Appendix, note 4.

the earth, wherein there is life, I have given every green herb for meat." And to this vegetable diet, before the close of the present scene, we are assured they shall again return so as to render the last age of the world as happy as the original state of man in Paradise.[1] This harmony of the animal creation, continued probably long enough, after the fall, to allow sufficient time for such a multiplication of the flocks and herds, and flights and shoals of the gregarious animals, as would secure them from extinction—but then, as the poet sings:

> ——— Discord first
> Daughter of sin, among th' irrational
> Death introduc'd through fierce antipathy:
> Beast now with beast 'gan war, and fowl with fowl,
> And fish with fish; to graze the herb all leaving,
> Devour'd each other; nor stood much in awe
> Of man but fled him, or with count'nance grim
> Glar'd on him passing. These were from without
> The growing miseries which Adam saw.

Had Adam not fallen, this sad change would, probably, never have taken place, for as the author of the book of wisdom argues:—" *God made not death, neither hath he pleasure in the destruction of the living. For he created all things that they might have their being; and the generations of the world were healthful: and there is no*

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[1] Isaiah, lxv. 25.

poison of destruction in them, nor the kingdom of death upon the earth." When we consider the relative position of man and the animal kingdom, by the divine decree, subjected to his dominion, the harmony and goodwill that subsisted between them, it appears improbable that immortal man would have been afflicted by the appearance of death and destruction amongst his subjects from any cause, especially by the strong, and those armed with deadly weapons, attacking and devouring the weak and helpless. Even now, fallen as we are from our original dignity, there is no creature so fell and savage that we have not more or less the power to subdue and tame; no natures so averse, that we are not skilled to reconcile; we can counteract even instinct itself, and make a treaty of peace and mutual good will between animals, whom nature, by a law, has placed in the fiercest enmity and opposition to each other.[1]

The Creator, indeed, foreseeing the fatal apostacy that plunged our race in ruin, and providing for the circumstances in which our globe would eventually be placed from the too rapid increase of various animals most given to multiply, furnished the predatory tribes with organs and offensive arms, which, when he gave the word and let loose the reins, would urge them to the work of destruction, and impel them to attack and devour without pity, those amongst the weaker animals, that were likely to increase in a degree hurtful to the general welfare, thus fulfilling his great purpose of generally maintaining those relative proportions, as to number, of individual species, that would be most conducive to the health and mutual advantage of all parts of the system of our globe.

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[1] See Appendix, note 5.

This too is the place to consider another circumstance connected with the appointment by Providence of certain animals to certain ends. There are, as must be evident to every one who thinks or observes at all, large numbers of the animal kingdom, which, considered in their individual capacities, may be regarded as positively injurious to man; and seem to have been created with a view to his *punishment*, either in his person or property. Of this description are those predatory tribes of which I have just spoken: but I here mean, more particularly, to advert to those *personal* pests, that not only attempt to derive their nutriment from him by occasionally sucking his blood when he comes in their way, as the flea, the horse-fly, and others, but those that make a settlement upon him or within him, selecting his body for their dwelling as well as their food, and thus infesting him with a double torment.

Besides those insects of a disreputable name[1] which, under more than one form, inhabit his person externally; and those that, burying themselves in his flesh, annoy him and produce cutaneous diseases,[2] a whole host of others attack him internally, and sometimes fatally. Can we believe that man, in his pristine state of glory, and beauty, and dignity, could be the receptacle and the prey of these unclean and disgusting creatures? This is surely altogether incredible, I had almost said impossible. And we must either believe, with Le Clerc and Bonnet, that all those worms now infesting our intestines existed in Adam before his fall, only under the form of eggs, which did not hatch till after that sad event: or that these eggs were dispersed in the air, in the water, and in various aliments, and so were ready to hatch when they met with their destined habitation: or, as some parasites are found in the earth,[3] or the water,[4] as well as in the human species, that they are in general formed for living in different stations:[5] or, lastly, that they were created subsequently to the fall of Adam, not immediately or all at once, but when occasions called for such expressions of the divine displeasure.

With respect to the first of these hypotheses, it seems to me very improbable for this reason, that it supposes the first pair to have in them the germes of all these animal pests, which although, before the fall, they were restrained from germination, after that event, were left to the ordinary action of physical laws, so that then every one of these scourges must have inhabited them and preyed upon them. Fallen indeed they were from glory and grace, but who can think that all the accumulated evils that their sin introduced into the world fell with concentrated violence upon their own heads, that all the various ills that flesh is heir to were experienced by them in their own persons before they were divided, some to one and some to another, amongst their posterity? It is scarcely to be supposed that any single individual, from that time to this, was subject to the annoyance of every one of these animals, and it seems incredible that Adam and Eve had experience of them all.

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[1] *Pediculi.* [2] *Sarcoptes Scabiei, Pulex penetrans, &c.*

[3] *Lumbricus.* [4] *Gordius aquaticus.*

[5] See *Introd. to Ent.* iv. 229.

That they had their existence originally either as germes or as perfect animals in the air, the earth, or the waters, and were taken in by man with his food, with respect to some species may, perhaps, be true. The earth-worm is often voided by children, and some other that infest animals are found in the water, but of those that are appropriated to man internally, none have as yet been found, except that just mentioned, in any other habitation. Linné indeed assigns an aquatic origin to the fluke, the ascarides, and the tape-worm, but he seems to have adopted this opinion upon very slight grounds. Bonnet very justly asks, with respect to the last of these animals, which Linné states he found once in a kind of ochre. "M. Linné is the only one that has made this discovery, now it is certain that if tape-worms existed out of the body of man and other animals, would it be possible, after the numerous researches that naturalists of every country have made in a variety of places, both in the earth and the water, none should ever meet with that insect?"[1] All Helminthologists seem now to be of opinion that the sole natural habitation of these animals is that in which they are usually found, the human viscera.

We now come to the last hypothesis, that these animals were created subsequently to the fall: a single instance from Scripture of such a creation will be sufficient to render it probable that others may have taken place when occasions called for such expressions of Divine displeasure. Every one is aware that God by the wonder-working rod of Moses converted all the dust of Egypt into some punitive animal or genus of animals, for they attacked man and beast, concerning the kind of which interpreters differ;[1] but this does not affect the question, it is evident that here is an instance of the creation of an animal in great numbers, and what is worthy of particular observation, that this animal was not afterwards again annihilated as the frogs, and others were. What has evidently been done once under circumstances that required it, though not recorded, may have been repeated, and thus all the punitive species in question may have been produced.

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[1] *Œuvr.* iii. 138.

This is given merely as an hypothesis, to account for the existence of these animals, without doing violence to probability; and rather in accordance with the word of God, than controverting any thing delivered therein—and if it excites a discussion that may throw new light upon the subject, which ever way the question is determined, I shall be well pleased—my object being rather to elicit *truth*, than to uphold *opinion*.

Another inquiry also suggests itself with respect to the original animal creation. Are any of those animals with which God peopled the earth, air, and waters, preparatory to the creation of man, now extinct? The answer to this question will principally depend upon that to another. Did any alteration take place in the climate and productions of our globe in consequence of the fall of man from his original state? We learn from the inspired penman, that God, induced by that sad event, pronounced a curse upon the ground, and predicted that it should produce in abundance noxious plants for the annoyance of the offending race of man, and that whereas the primeval earth brought forth spontaneously her fruits and flowers, and afforded man a pleasant and delightful recreation and employment, without subjecting him to toil and weariness; this state of things should cease, and man, for the future, should earn his bread with difficulty by the labour of his hands and the sweat of his brows. From hence it seems to follow that at this time some great change took place, both with respect to climate, and to that blessing from atmospheric influences which produces plenty and fertility with the lowest amount of labour. Geologists have observed, from the remains of plants and animals embedded in the strata of this and other northern countries, that the climate must formerly have been warmer than it now is.[1] Some change or changes of this kind therefore would sooner or later produce the extinction of such animals and plants, inhabitants of northern countries, as could not bear such a change of temperature, and at the same time could not escape from it; and admitting this—it would enable us to answer in the affirmative to the query above stated—namely, that there were species of animals originally created which have since ceased to exist. Being no longer necessary to bear a part in carrying on the general plan of Divine Providence with regard to our globe, they were permitted or caused to perish.

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[1] See Appendix, note 6.

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[1] See Appendix, note 7.

One circumstance, which I have not seen adverted to, seems to confirm this hypothesis: that so few fossil remains, if any, of tropical *birds* have hitherto been discovered in cold countries, while such numbers of the quadrupeds of warm climates, both viviparous and oviparous, are met with every day in a fossil state. Now the birds could readily shift their quarters southward, when the temperature grew too cold for them, while the quadrupeds might be stopped by seas, rivers, and other obstacles.

Another question may be asked with respect to the subject I am discussing; might not the animals now become superfluous have been excluded from the ark at the time of the general deluge, and so left to perish? This would furnish a very easy solution of the difficulty, but the text of Scripture seems too precise and express to allow of such a supposition. For the command to Noah is—"*Of every living thing of all flesh, two of every sort shalt thou bring into the ark.*" But yet the terms here employed must be limited to those animals that required such shelter to preserve them from destruction by the diluvial waters; so that the expression—"*of all flesh*"—necessarily admits of some exceptions.

But there are doubtless very many animals still existing upon the earth and in its waters, that have not yet been discovered. When we consider the vast tracks of terra incognita still shut out from us in the heart of Africa, that fatal country hitherto as it were hermetically sealed to our researches, and from whose bourn so few travellers return; how little we know of Central Asia, of China, and of some parts of North America; we may well believe that our catalogues of animals are still very short of their real numbers, even with respect to those of the largest dimensions. Burchell and Campbell appear to have met with more than one new species of rhinoceros in their journey from the Cape of Good Hope into the interior;[1] the same country may conceal others of the same gigantic or other tribes, which, when it is more fully explored, may hereafter be brought to light.

Again, with regard to the productions of the various seas and oceans that occupy so large a portion of our globe, we know comparatively few, especially of its molluscous inhabitants. What are cast up on the shores of the various countries washed by their waves, and what the net or other means may collect in their vicinity, find their way indeed into our cabinets; but what are these compared with such as inhabit the depths and caves and bed of the infinite ocean, which net never dragged, nor plumb-line fathomed. Who shall say what species lurk in those unapproachable recesses never to be revealed to the eye of man, but in a fossil state. The giant *Inocerami*, the singular tribe of *Ammonites*, and all their cognate genera, as even Lamarck seems disposed to concede:[1] the *Baculites*, *Hamites*, *Scaphites*, and numerous others there have space enough to live unknown to fame, while they are reckoned by the geologist as expunged from the list of living animals. I do not mean to assert that these creatures are not extinct, but I would only caution the student of nature from assuming this as irrefragably demonstrated; since we certainly do not yet know enough of the vast field of creation, to say dogmatically with respect to any species of these animals that this is no longer in being.

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[1] See Appendix, note 8.

But besides the unexplored parts of the surface of the earth, and of the bed of the ocean, are we sure that there is no receptacle for animal life in its womb? I am not going here to revive the visionary speculations of Athanasius Kircher in his *Mundus subterraneus*, but merely to inquire whether there are any probable grounds for thinking that some creatures may be placed by their Creator at such a depth within the earth's crust, as to be beyond all human ken.

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[1] In N. D. D. H. N. vii. 553.

When Laplace says, "It is certain that the densities of its *(the earth's)* strata increase from the surface *to* the centre," it seems to follow that, in his opinion, there is no central cavity in our globe; but as his object was chiefly to assert the increasing density of the strata as they approach the centre, perhaps his words are not to be taken strictly, especially as in another place he speaks of it merely as *probable* that the strata are more dense as they are *nearer* to the centre. Sir I. F. W. Herschel makes a similar, but less exclusive observation, using the terms, "*towards* the centre," which is not inconsistent with a cavity.

But after all this is matter of conjecture built upon the attraction of the earth, and cannot be ascertained by actual examination; as far as that has been carried, it does not appear that in the present state of our globe the strata always lie exactly in the order of their densities; in the original earth probably they did. But now we tread upon the ruins of a world that has been almost destroyed and reformed. "The structure of the globe," observes an eminent geographer, "presents in all its parts the features of a grand ruin; the confusion and overthrow of most of its strata, the irregular succession of those which seem to remain in their original situations, the wonderful variety which the direction of the veins and the forms of the caverns display, the immense heaps of confused and broken substances, the transportation of enormous blocks to a great distance from the mountains of which they appear to have formed a part,"[1]—do not lead us as he would intimate "to periods far anterior to the existence of the human race," but to a mighty catastrophe by which the whole structure of our globe has been dislocated, and its ancient strata broken up, and separated by the intervention of new ones formed of animal and vegetable remains.

When the Almighty formed our globe from the original chaos, and projecting it into space bade it perform its diurnal and annual revolutions, he first weighed it in his balance, and moulded it so as it might answer to the action of those mighty powers by whose constant impulse or impact those revolutions were to be maintained; and if a central void was necessary he wanted not the means to produce and maintain it. When the power called attraction tended to drive all to the centre, the repellant principle might be so stationed as to counteract it, and keep the earth's crust at its assigned distance. To compare great things with small, he who made the rain-drop made also the air-bubble,—the one to fall, the other to rise.

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[1] Malte-Brun *Syst. of Geogr.* L. i. 192.

The word of God, in many places, speaks of an abyss of waters under the earth, as distinct from the ocean though in communication with it,[1] and also as contributing to form springs and rivers.[2] Scientific men, in the present day, appear disposed to question this; the Geologist, though he may regard the granitic strata as forming the base, as it were, of the crust of the earth, seems rather to view it as containing a focus of heat, than a magazine of infinite waters; from whence are partly derived the springs and rivers that water the earth's surface, and ultimately make good to the ocean its whole loss by evaporation.[3] "Springs," says the author above quoted, "are so many little reservoirs, which receive their waters from the neighbouring ground, through small lateral channels." He allows, however, that the origin of springs cannot be referred to one exclusive cause, and associates with that just mentioned, the precipitation of atmospheric vapours attracted by high lands, the dissolving of ice, the filtering of sea-waters, and the explosion of subterraneous vapours. He makes no direct mention of a storehouse of waters in the bosom of the earth as in any case the source of springs and rivers, but allows that "the phenomena of capillary tubes may obtain in its interior. The sea-waters, deprived of their salt and bitter elements, may ascend through the imperceptible pores of several rocks, from which, being disengaged by the heat, they will form those subterraneous vapours to which many springs owe their origin." A very slight alteration of this passage would make it harmonize with the Scripture account of the matter. If, for "some rocks," we substitute *through the rocky strata*, and to the "sea-waters" add *received into the abyss*, it would amount to nearly the same thing. It was an ancient opinion, mentioned in Plato's Phædon, that there is a flux and reflux of the waters of our globe, a kind of systole and diastole, into and from Tartarus or the great abyss, which produce seas, lakes, rivers, and fountains.[1] That all the causes mentioned above contribute to the formation of the rivers that water the earth, especially the clouds and vapours that gather round the tops of the mountains and high hills I am ready to admit, at the same time I must contend that the principal reservoir from which they are supplied has its station *under the earth.*

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[1] Comp. Job, xxviii. 14, xxxviii. 16, 17.—Genes. xlix. 25.—Deut. xxxiii. 13.—Jonah, ii. 6, &c.

[2] Ps. lxxviii. 15, 16.—Prov. viii. 24.

[3] See Appendix, note 9.

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[1] Platonis *Dialogi*. Ed. Forst. *Phædon*. § ξ.

Writers on this subject seem to speak as if the source of all rivers was in mountainous or hilly countries, but though the mightiest rivers of the globe originate in such situations, there is a very large number of considerable streams whose source is not particularly elevated, especially in the flat parts of England; and there are few rivers that do not receive some supply from lesser ones, having their rise in low grounds, in their course. The practice, in all countries, of digging wells indicates a downward source of water.

In the Mosaic account of the deluge it is stated, that the waters prevailed above the tops of all the mountains fifteen cubits—now the highest mountain in the globe, Dhawalagiri, a peak of the Himmaleh range in northern India, is five miles above the level of the sea, this will make a sphere of waters, inclosing the whole globe as its nucleus, of five miles in depth above the level of the sea, but in calculating the immense additional body of water thus burying the whole globe, deductions must be made for the mountains and the lands elevated above that level, which would considerably decrease the total amount. But, even then, how vast would be the increase. If two fifths of this body were deducted, a deluge of rain for forty days and forty nights over the whole globe, would fall infinitely short of the amount of water required to cover it to this height. The mean quantity of rain that now falls upon the earth in the course of a whole year is short of three feet; there must therefore have been an outbreak of waters from a source which could supply all that was necessary to accomplish the will of the Almighty, and make the earth itself a ruin, as well as sweep off its inhabitants; and where shall we look for this but to the abyss that *coucheth beneath* the earth, whose fountains, as the sacred historian tells us, were broken up. If we consider the diameter of our globe, and that the ocean in depth is not supposed to exceed the highest mountains, we may conceive that in a spheroid, whose diameter is 8000 miles, allowing for the depth of the crust of the earth, there is space for a treasure-house of water, of sufficient amplitude to supply what the heavens could not furnish, to raise the diluvial waters to the height decreed in the Divine counsels. It seems now agreed amongst geologists and mineralogists that traces of the action of fire, as well as water, are very visible amongst the present strata of this globe: when the waters of the abyss were sent out from their hidden receptacle, it must be by the agency of some potent cause employed by the Deity, equal to the production of the effect he intended.

In the present state of the globe, volcanos, or their traces are visible in various regions in all climates, and in the islands of various seas, and in Iceland, near Hecla, the subterranean furnace sends vast columns of water into the air, sometimes to the height of a hundred feet, and at the base of half that diameter.[1] These circumstances render it probable that fire was the agent, or one of the agents, employed to send out the waters from the abyss; and this is no new hypothesis. "It is the opinion of geologists," says Laplace, "that, originally, there existed in the interior of the crust of the earth, a great magazine of fire, which according to them was the cause of the deluge." Some writers suppose that the air was driven downwards into the earth, being forced through those chasms which opened towards the sky, and that then by its expansion it drove out the water.[2]

He who willed the deluge, and the destruction of the primeval earth and heavens by it,[3] kept in his own hands the reins, and guided the whole body of means that he employed to fulfil the great purposes of his Providence, saying to every agent, "*Thus far shalt thou go, and no further.*" It must always be kept in mind that this was not an event in the ordinary course of nature, and a result of the enforcement of her established code of laws, but a miraculous deviation from it, in which their action was suspended, and in consequence of which, perhaps, some were abrogated and new ones enacted in their room. I may here further observe, that probably, the whole body of waters which before the creation of the firmament or expanse, with the earthy atoms suspended in it, formed the primeval chaos, were now again its masters; descending and ascending from every receptacle or storehouse to which that powerful expansion had been the means employed to guide them. Whatever waters were suspended in the atmosphere, or could be formed in it, whatever were contained in the ocean, or the womb of our globe, now united their forces and subdued and destroyed the primitive earth, till they reduced it to the state, for the most part, in which we now behold it.

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[1] See Hooker's Recollections of Iceland, 120.

[2] Rev. W. Jones' *Works*, x. 264.

[3] Pet. iii. 6, 7, and see Appendix, note 10.

I am next to inquire what has been said in scripture on the subject of subterranean animals. In the second commandment we are forbidden to "*make any likeness of any thing that is in the waters under the earth.*" These words, however, may be merely used to indicate the animals that inhabit the ocean, considering the waters under the earth as forming a part of it. But there is a passage in the Apocalypse, where the creatures under the earth are distinguished from those in the sea. "*And every creature which is in heaven and on the earth, and under the earth, and such as* *are in the sea, and all that are in them, heard I saying, Blessing, and honour, and glory and power, be unto him that sitteth upon the throne, and unto the Lamb for ever and ever.*"[1] Some interpreters understand this passage as relating to those men that were buried under the earth, or in the sea, but admitting they were meant in the *spirit*, the creatures in general are expressed in the *letter*, and therefore the outward symbol must have a real existence, as well as what it symbolized.

There is another place in scripture, which though highly metaphorical, seems to me, to point, if rightly interpreted, at subterranean animals, and even a particular description of them. The passage I allude to is in the xlivth Psalm, "*Though thou hast sore broken us in the place of* dragons *and covered us with the* shadow of death."[2] In these words the *place of dragons* and the *shadow of death* evidently mean the same thing; and the object of these metaphors is to express the lowest degree of affliction, depression, and degradation; equivalent to being brought down to hell or hades in other passages. The *shadow of death*, properly speaking, is in the hidden or subterranean world. This appears from the passage of Job before quoted, in which the *abyss*, the *gates of death*, and the gates of the *shadow of death*, are used as synonymous expressions.[1] The place of dragons, then, according to this exposition, will be subterranean. In another Psalm, David couples *dragons* and *abysses*.[2]

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[1] Revel. v. 13.

[2] Ps. xliv. 19.

We must next inquire what is meant by the word *dragons*. The Hebrew word usually thus translated, but in some places rendered *whales* and *sea-monsters*, and in others serpents,[3] is derived from a root, which signifies to wail or lament; probably, alluding to the noise at certain times emitted by those animals, that are more properly regarded as *dragons*, by which I would understand the Saurian race, without excluding the others, which are sometimes certainly intended by that word. Thus, when Jeremiah alludes, under the name dragons, to animals that give suck to their young, it is clear that he meant some of the whale or seal kind, which are mammiferous. Our translators, therefore, very properly rendered the word *sea-monsters*, or as in the margin, *sea-calves*. I may here observe, though at first sight, the crocodile and the whale seem widely separated from each other, that there are certain species, at present found only in a fossil state, and fitted with paddles instead of legs, which are stated to combine characters observable in the Cetaceans with those of the

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[1] Job, xxxviii. 16, 17.

[2] Ps. cxlviii. 7.

[3] Genes. i. 21. Lament. iv. 3. Exod. vi. 9, 10.

Saurians, particularly the *Plesiosaurus*;[1] the *Testudo* also of the Greeks[2] seems to approach some of the seals. The word we are considering, in the first chapter of Genesis, is rendered by our translators, *whales*. In the version of the seventy, a word is used,[3] which the Greek writers employ to signify any aquatic monster; thus, Theocritus, when he describes the Nile as abounding in monsters, means the crocodile. Our Saviour, when he speaks of Jonah in the belly of the fish, uses the same word, probably, for a shark, the dog Carcharias of the Greeks, which was fabled to have swallowed Hercules, a fable, no doubt, derived from the history of Jonah.

It appears clearly that the word is also used for a serpent, for it is employed to express the animal into which the rod of Moses and those of the Egyptian magicians were transformed as related in the book of Exodus.

The typical animal, however, if I may so employ that term, or the dragon proper of scripture, is undoubtedly a Saurian, especially the amphibious ones, such as the crocodile and its affinities. In the Septuagint version the Hebrew word is sometimes rendered by the term Siren, which in other places is used for the ostrich,[4] derived from a root which relates to its noise, but the Siren of the Greeks is very different from that of these Jews—the former being a fabulous, the latter a real animal. Travellers describe the noises of crocodiles and alligators as horrible. Crocodiles, during the whole summer, says Bosc, but especially immediately after they emerge from the earth, that is in the spring and the epoch of their amours, frequently send forth lowings almost as loud as those of an ox. They respond to each other often by hundreds, especially in the evening, which makes in the swampy forest a frightful and thundering din. Captain Jobson says, that those of the river Gambia utter cries that may be heard from a great distance, which seem as if they issued from the ground.

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[1] Mantell's *Age of Reptiles*.—Sussex Gazette.

[2] *Sphargis coriacea*.

[3] *τα κητη τα μεγαλα*.

[4] Isai. xiii. 21.—Job, xxx. 29, &c.

The whale also, when it expels the water, is related to make a frightful noise, like distant thunder. Captain Cook represents the walrus, when in herds, as roaring or braying very loud, and some species of seals are stated to bellow like bulls.

The hissing of serpents agrees less with the radical idea of the word *dragon*, than the noises of either of the preceding tribes of animals. The aquatic and amphibious Saurians occupying, as it were, a middle station between the Cetaceans and Ophidians, may be regarded, therefore, as the *dragons* par excellence.

These, then, are the animals that I conjecture may not improbably be still in existence in the subterranean ocean; I shall now, therefore, bring forward some arguments, independent of what I have alleged from Holy Scripture, which seem to afford grounds for such an hypothesis.

It has been calculated that the depth of the sea in any part does not exceed 30,000 feet, or a little more than five miles; this, compared with the diameter of our globe, about 8000 miles, may be regarded as nothing. What a vast space then, supposing it really hollow, may be contained in its womb, not only for an abundant reservoir of waters, but for sources of the volcanic action, which occasionally manifests itself in various parts, both of the ocean and terra firma. Reasoning from analogy, and from that part of the globe which falls under our inspection, it will appear not improbable that this vast space should not be altogether destitute of its peculiar inhabitants. We know that there are numerous animals, on the surface of the globe, that conceal themselves in various places in the day time, and only make their appearance in the night. It would, therefore, be perfectly consistent with the general course of God's proceedings, and in exact harmony with the general features of creation, that he should have peopled the abyss with creatures fitted, by their organization and structure, to live there: and it would not be wonderful that some of the Saurian race, especially the marine ones, should have their station in the subterranean waters, which would sufficiently account for their never having been seen except in a fossil state.

The organization of many reptiles favours the idea of their being fitted for a subterranean habitation. It has been observed of them, that they not only perceive objects at a great distance, but are furnished with a nictitant membrane like birds; and that the greater part can contract the pupil like cats, which enables them to see in the dark. Their other organs furnish them with but few sensations: they communicate less frequently and less perfectly with external objects; their blood is cold, and will circulate a long time without communication with the air. They will bear very long fasts without injury; and those of some tribes, the Chelonians at least, will survive for a time the loss of their brain, their heart, and even their head. These circumstances are found in those that only occasionally seek subterranean retreats, or seclusion from the light and the air; but those whose existence is wholly subterranean, doubtless, like the *Proteus*, would be fitted by their organization for their destined abode. We see, in several of those we are acquainted with, except at certain times, a constant effort to escape not only from observation, but from immediate contact with the light and the air.

This leads me further to observe, that there is one instance of a Saurian, at this time known to be in existence, that is perfectly subterranean, which never makes its appearance on the earth's surface, but is always concealed at a considerable depth below it; and, what is worthy of particular notice, by its structure, is connected with one of the larger Saurians, now found only in a fossil state. It will immediately be perceived that I allude to that most extraordinary animal, the *Proteus anguinus*,[1] which is found in subterranean lakes and caves two or three hundred feet below the surface of the ground in Illyria, breathing both by lungs and gills, and presenting characters which connect it with the Saurian monsters before alluded to, whose remains have occasioned so much astonishment, appear to have puzzled in some measure the most acute geologists, and have given birth to an hypothesis I shall hereafter notice. Sir H. Davy, in his last singular work, thus expresses himself concerning the *Proteus*:—"My reveries became discursive, I was carried, in imagination, back to the primitive state of the globe, when the great animals of the Sauri kind were created under the pressure of a heavy atmosphere; and my notion on this subject was not destroyed, when I heard from a celebrated anatomist, to whom I sent the specimens I had collected, that the organization of the spine of the *Proteus* was analogous to that of one of the Sauri, the remains of which are found in the older secondary strata." Sir Humphry probably here alludes to a celebrated fossil found in the slate quarries of Œningen, which Scheuchzer called an antediluvian man, but which Cuvier regards as a giant species of *Proteus*.

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[1] PLATE xiv. FIG. 1.

All the circumstances above stated being duly weighed, and especially the discovery of a species in the depths of the earth, related to one of the fossil ones, I trust that my hypothesis of a subterranean metropolis for the Saurian, and perhaps other reptiles, will not be deemed so improbable and startling as it may at the first blush appear; at the same time, I would by no means be thought to contend that *none* of these animals are extinct, but solely that *all* may not be so, and that their never having been found in a recent state may have arisen from the peculiar circumstances of their situation.

I have been led into this discussion by Mr. Mantell's Hypothesis of an *Age of reptiles*, which I have seen only in an extract from one of the Sussex advertisers for last year, which he was so kind as to send to me; in which he supposes that the Saurians were the mighty masters, as well as monsters, of the primeval animal kingdom, and the lords of the creation before the existence of the human race. Since this hypothesis, as stated in the above extract, cannot be reconciled with the account of the creation of animals as given in the first chapter of Genesis, I shall not be wandering from the purpose of the present essay if I devote a few pages to the consideration of it.

The hypothesis in question is based by its learned promulgator chiefly upon the supposed age of the beds and strata in which the remains of these fossil Saurians generally have been found, which he states as more ancient than those which contain the remains of viviparous animals; and upon the myriads which appear, when they were the lords of our globe, to have existed. But it is clear from his own statement that with the fossil remains of the *Megalosaurus*, a giant lizard, calculated to have been forty feet in length and eight in height, those of some viviparous quadruped related to the *Opossum* have been found, which he acknowledges cannot be satisfactorily explained. A fact that militates strongly against an insulated Saurian reign. Nor is it altogether true that the remains of these mighty lizards are found solely in what are denominated *ancient* deposites; vertebral joints are not unfrequently found in other situations. I have one between three and four inches in diameter, which, from its being cupped, or deeply concave at each extremity, evidently belongs to one of these animals, which was found in a gravel-pit, at no great depth, in my own neighbourhood; and I have seen similar ones found in other parts of the county of Suffolk. These dispersed bones seem to indicate that the individuals to which they belonged were deposited in situations more exposed to the action of the atmosphere, so as to decompose the ligaments that kept the skeleton entire. The interment of these animals was therefore various, and evidently regulated by circumstances, so that no satisfactory hypothesis can be built upon it. When the whole globe was submerged, and the waters overtopped the highest mountains, the terrestrial animals would, in numberless cases, float upon the surface, and be deposited in countries far distant from those which they inhabited, while those that were aquatic, being in their native element, must have owed their death to other circumstances; they must either have been overwhelmed by some sudden force that they could not resist or escape from; or some cause that we cannot now appreciate may have overtaken and destroyed them.

With regard to the *numbers* of these animals, which Mr. Mantell thinks prove their prevalence, we can only judge of it by those that are found in a fossil state, and these, certainly, are sufficiently numerous; but surely it cannot be safely affirmed that for one individual found in a fossil state thousands must have been devoured or decomposed. These mighty monsters were more likely to devour than to be devoured; and even the herbivorous ones, such as the vast *Iguanodon*, supposed to be sometimes one hundred feet long and ten feet high! would have puzzled the crocodiles and alligators and other carnivorous ones to overpower and dispatch them.

But, in fact, the question is concerning those that were alive upon this globe at the time when the great convulsion took place that buried them. The skeletons of all that were placed under similar circumstances would be found in a similar state of preservation; their flesh would be decomposed but not their skeleton; the deluge would also interrupt all attacks of one animal upon another, every individual would be seeking to secure its own escape. But, setting aside these arguments upon the uncertain facts on which this hypothesis is built, if we turn our attention to the reason of the thing, who can think that a Being of unbounded power, wisdom, and goodness should create a world merely for the habitation of a race of monsters, without a single rational being in it to glorify and serve him. The supposition that these animals were a separate creation, independent of man, and occupying his eminent station and throne upon our globe long before he was brought into existence, interrupts the harmony between the different members of the animal kingdom, and dislocates the beautiful and entire system, recorded with so much sublimity and majestic brevity in the first chapter of Genesis.

How grand and at the same time how simple is this record, proceeding step by step from one Almighty operation to another! each the natural consequence, as it were, of that which preceded it. When the earth was formed, and planted, and was receiving the influences of the sun and other luminaries, and thus was prepared to welcome and maintain her locomotive inhabitants, the perfect sphere of animals, if I may so speak, adapted to the wants of the primeval state of the globe of dry land and sea, both external and internal, and to the instruction and uses of man, each individual form gifted and fitted to play the part assigned to it in the general plan of Providence, was brought into existence. The supposed extinct animals all exhibit a relationship to those that we now find existing, and many of them evidently fill up vacant places in the general system, and therefore there is no cause to suppose that they were originally separated from and anterior to their fellows. It is observed that those herbivorous Saurians now inhabiting the surface of our globe, as the *Monitor* and *Iguana*, though these can scarcely be called herbivorous since they live principally on insects, are pigmies compared with their affinities, the *Megalosaurus* and *Iguanodon*; and a similar disproportion obtains between the existing *Proteus* and the fossil one. If any of these races are subterranean, perhaps these smaller ones may be regarded, as inhabiting the outskirts of the proper station, or metropolis of their tribe.

It appears, I hope, from what has been observed, in the present chapter, on the subject of animals brought into being subsequent to the fall, and upon those that have since that sad event become extinct from whatever cause, that Divine Providence, after the first creation of man and the animal kingdom, did not leave all things to the action of the original laws which had received his awful sanction before the fall, but altered those by which this system, especially our own globe, was guided and governed before that fatal event, to suit them to what had taken place, and to the altered and deteriorated moral state of man. We learn from the Apostle Saint Peter, that the primeval globe and its *heavens* or atmosphere, *perished* at the deluge,[1] by which expression less cannot be intended, than that the atmosphere and the earth were then, as it were, new mixed, so as to render the former less friendly to life and health, whence would gradually follow the shortening of human, and probably animal life; and subject to raging storms and hurricanes; to the fury and fearful effects of thunder and lightning; to the overflowing violence of torrents of rain: while the latter, from the breaking up, inversion, mixing, depression, or elevation of its original strata, and the addition of new ones from animal and vegetable deposites,[2] was rendered in many places utterly barren, and in others much diminished in fertility, so that the general productiveness of the globe must have been considerably diminished, and the permission to eat flesh must have been extremely useful in increasing the amount of food, and diminishing that of labour. Such a change having taken place, both in the heavens and the earth, and vast countries being essentially altered both in the temperature of the atmosphere, from whatever cause, and the productions of the soil, the extinction of many of the original animal forms, that were extra-tropical, or at least were inhabitants of high latitudes, and were incapable of bearing the changes, whether it was ante-diluvial or post-diluvial, would necessarily follow; and again as man was become by his nature prone to *sin*, he as necessarily was made subject to *evil*. Hence he became exposed, from the new constitution of the earth and atmosphere, to various diseases and sundry kinds of death, the term of his existence was shortened, and it was chequered with days of darkness as well as of light: and he was infested by various animals, either newly created, or then first let loose against him and his property.

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[1] Gr. *απωλετο*. 2 Pet. iii. 6.

[2] See Appendix, note 11.

All these things indicate a change in the mechanical as well as other original powers set and kept in action by the Creator, and a certain dependence of two distinct classes of events upon each other. If a great alteration generally takes place in the moral condition of man, a corresponding change affects his physical one; and this alternation and conflict between good and evil, in this double series, after a long and arduous struggle, will finally be determined by the destruction of this diluvial earth and heavens, which we are assured will, in the end, be replaced by "*New Heavens and a new Earth wherein dwelleth righteousness.*"

CHAPTER II.

Geographical and Local Distribution of Animals.

HAVING considered the first creation of the animal kingdom, and the larger features of its history to the time of the Deluge, bringing us to that era when our globe had assumed its present general characters, and its population was in those circumstances that led to their present habits and stations: the next subject to be discussed is their geographical and local distribution.

What had taken place in this respect before the Deluge we have no means of ascertaining. That the original temperature of the earth was once more equal than it is now, seems to be the general opinion of men of science, however they may differ as to its cause.[1] If this was the case, as it probably was, any individual species might have been located in any country, north or south, and suffer no inconvenience from unaccustomed heat or cold, so as to interfere with its complete naturalization: the only other requisite would be a kind of food suited to its nature; and it is singular and worthy of particular attention, that a large proportion of the plants, as well as animals, that are found in a fossil state in our northern latitudes are of a tropical type or character.

After their creation, and perhaps the expulsion of the first pair from Paradise, we may suppose that the various animals of the antediluvian world were guided to those regions in which it was the will of Providence to place them, by a divine impulse upon them, which caused them to move in the right direction. Probably before the Deluge took place, the world was every where peopled with animals: and perhaps, as Professor Buckland has suggested, the sudden change of temperature that destroyed the northern animals might be one of the predisposing causes of that event.

Under the present head, the geographical distribution of our postdiluvian races of animals, the first thing to be considered is the means by which, after quitting the ark, they were conveyed to the other parts of the globe. The disembarkation of the venerable patriarch and his family, followed by all the animals preserved with him in the ark, a scene of universal jubilee to man and beast, such as the world till that day had never witnessed, took place on Mount Ararat: the stream of interpreters, ancient and modern, place this mountain in Armenia; but Shuckford, after Sir Walter Raleigh, seems to think that Ararat was further to the east, and belonged to the great range anciently called Caucasus and Imaus, which terminates in the Himmaleh mountains to the north of India. This opinion seems to receive some confirmation from Scripture, for it is said, "*As they journeyed from the* east, *they found a plain in the land of Shinar*." Now the Armenian Ararat is to the *north* of Babylonia, whereas the Indian is to the *east*. Again, as the ark rested upon Ararat more than *ten* weeks before the tops of the mountains were seen, it seems to follow that it must have been a much higher mountain than the generality of those of the old world. The modern Ararat (Agri-Dagh) is not *three* miles above the level of the sea, whereas the highest peak of the Himmaleh range, Dhawalagiri, is *five*, and the highest mountain in the known world: so that the tops of a great number of mountains would have appeared previously had the ark rested upon the former Ararat, but not so if upon the latter.

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[1] See above, p. 17, &c.

The traditions also of various nations, given by Shuckford, add strength to this opinion. In addition to these, the following lines, quoted in a late article on Sanscrit poetry, in the Quarterly Review, shew what was the creed in India on this subject:—

In the whole world of creation————
None were seen but these seven sages, Menu and the fish;
Years on years, and still unwearied, drew that fish the bark along,
Till at length it came where reared Himavan—its loftiest peak;
There at length they came, and, smiling, thus the fish addressed
the sage:—
Bind thou now thy stately vessel to the peak of Himavan—
At the fishes' mandate, quickly to the peak of Himavan:
Bound the sage his bark, and even to this day that loftiest peak
Bears the name of Naubandhana.

Both these opinions have their difficulties, which I shall not further discuss, but leave the decision of the question to persons better qualified than myself to direct the public judgment: I shall only observe, that perhaps the Indian station was more central and convenient for the ready dispersion of men and animals than the Armenian one. Every naturalist is aware that there are many animals that, in a wild state, are to be found only in particular countries and climates. Thus the Monkey and Parrot tribes usually inhabit a warm climate, the Bears and Gulls with many other Sea-birds, for the most part a cold one. The Kangaroo and Emu are only found in New Holland;

the Lama in Peru; the Hippopotamus and Ostrich in Africa. Now we may ask, how were all these local animals conveyed from the place of disembarkation to the countries and climates that they severally inhabit? In considering this question, we must never lose sight of HIM, according to whose will, and by whose Almighty guidance, they were all led to the stations he had appointed for them, and with reference to which he had organized and formed them. Whatever second causes he might commission to effect this purpose, they were fully instructed and empowered by him to accomplish the work intrusted to them. I do not mean here to infringe the rule, *Nec Deus intersit nisi dignus vindice nodus.* Where the faculties, senses, and wants of an animal were sufficient for its guidance, there was no need for Divine interposition, but where these are insufficient guides, the animal must attain its destined station under some other influence.

What brought the various animals to the ark previously to the deluge? Doubtless a *divine* impulse upon them, similar to that which caused the milch-kine to carry the ark of the covenant to Bethshemesh, with the offerings of the lords of the Philistines. Noah, though he probably selected the clean animals, at least those that were domesticated, could have little or no influence over the wild ones to compel them to congregate by pairs, at the time fixed upon for their entry into the ark. So in the dispersion of animals, wherever man went he took his flocks and herds, and domestic poultry, and those in his employment for other purposes, with him: but the wild ones were left to follow as they would, or rather as God directed.

Every one who looks at a map of the world, on Mercator's projection, can easily conceive how the animal population of the greatest part of the old world made their way into the different countries of which it consists, but when he looks at America and New Holland, he feels himself unable satisfactorily to explain the migration of animals thither, especially those that can live only in a warm climate, at least as far as regards the former. How, he might ask, did the Sloths, the Anteaters, and the Armadillos get to South America? If the climate of Behrings Straits, after the deluge, was as cold as it is at this day, they could never have made their way thither, and in those latitudes the temperature of which was adapted to their organization the vast Pacific presents an insuperable barrier.

The same question may be asked with respect to the indigenous animals of New Holland; the Kangaroo, the Cola, the Ornithorhynchus, the Emu, and several others that are found in no other country; how did they, leaving the continent altogether, convey themselves to this their appointed abode? It is true the difficulty is not so great in this last case, on account of the numerous islands interposed between Malacca, Cochin-china, &c. and the North Coast of New Holland, but then it is unaccountable, if the transit of these animals was gradually effected by natural causes, and following that of mankind from island to island, till they reached the country to which their range is now limited, that they should have left no remains of their race in the countries and islands which they must have traversed in their route; and those that would have accompanied man would be a different tribe of animals, more fitted to minister to his wants, so that with respect to these the difficulty still remains—they could not have reached the country unless under the guidance of Providence, and the same power that accomplished their removal to that appointed for their residence, prevented their leaving any of their race in the regions through which they passed.

There is only one supposition that will enable us to account for the transport of these animals in a natural way, which is this, that immediately subsequent to the deluge, America and New Holland, and the various other islands that are inhabited by peculiar animals, were once connected with Asia and Africa, by the intervention of lands that have since been submerged. Plato, in his Timæus, relates a tradition concerning an island called Atlantis, which he describes as bigger than

Asia and Africa, situated before the pillars of Hercules, which after an earthquake was swallowed up by the sea. According to his statement, this account was given by the Egyptian priests at Sais, to Solon, the Athenian legislator. Catcott, in his history of the deluge, seems to give some credit to this tradition, and supposes that Phaleg took his name, not from the confusion of tongues at Babel, and the subsequent division of the earth amongst the families of the three sons of Noah, but from its division occasioned by the subsidence of this great island, by which the occidental were separated from the oriental countries of the globe. Philo Judæus speaks of this catastrophe in terms that imply he gave credit to it, as does also Tertullian; but it appears to me to rest on too uncertain a base, and to be too much mixed with evident fable and allegory, to claim full credit as a real fact in the history of our globe. Still that many violent convulsions have taken place since the deluge is generally supposed. Our own island is thought once to have formed part of the continent, Sicily to have been united to Italy, with many other instances mentioned by Pliny. It is equally probable that the islands of the Indian Archipelago were at one time joined to that part of Asia. Whether such disruptions from the continents were simultaneous, or took place at different periods, is uncertain; but if such an event as the submersion of the vast island of Plato did really happen, it surely would affect the whole terraqueous globe, produce convulsions far and wide, and cause various disruptions in its crust, and elevations in other parts from the bed of the ocean. It throws some weight into this scale, that thus a way would be open, though certainly a circuitous one, for the migration of those animals to America, that are found in no other part of the world, and, supposing Asia to have been disrupted from it at Behrings Straits, could scarcely have ascended to so high a latitude, in search of their destined home.

Malte-brun, in his geography, after proving that the animals in question could have passed neither from Africa nor Asia, observes—"Nothing, therefore, remains, but the accommodating resource of a tremendous convulsion of nature, with a vast tract of country swallowed up by the waves, which formerly united America with the temperate regions of the old world. Such conjectures as these, however, being devoid of all historical support, do not merit a moment's consideration; consequently we cannot refrain from admitting, that the animals of America originated on the very soil, which, to this present day, they still inhabit."

That it might have been the will of the Creator to people the country in question by the immediate production of a new race of animals, suited to its climate and circumstances, I will not deny, but I would only ask, is it consistent with what occurred at the Deluge? Surely the task of Noah would have been much less difficult and laborious, had it been merely necessary for him to construct a vessel fitted for the reception of himself and family, and of food for their sustenance during their confinement; and a new race of animals had been created, adapted to the then state of the earth and mankind. But such was not the will of God, and, doubtless, for wise reasons. He would neither create a new race of men, nor a new race of animals, when the world might be repeopled by those already in being. This would not have harmonized with the ordinary proceedings of his providence. Whoever examines the animals of North America, will find a vast number that correspond with European species, distinguished only by characters that mark varieties. On the Rocky Mountains, and in the country westward of that range, Asiatic types are discoverable, both in the vegetable and animal kingdoms.[1] Several animals, likewise, of the southern part of that Continent belong to old world genera, and also species. I have received from Val Paraiso a beetle, common in Britain,[2] and Molina mentions several other European genera, as natives of Chili; so that part of the animal population of the New World appears to have been derived from Europe and Asia; and if so, there is a door open, through which Providence might also have conducted those North American animals that are found in no other country.

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[1] See Appendix, note 14.

[2] *Sphodrus Terricola.*

But besides the probable, or possible, modes by which the transit of animals to their respective settlements might have been accomplished, Mr. Lyell, in the second volume of his Principles of Geology, has suggested one which might, amongst others, have been employed for this purpose.

"Captain W. H. Smyth informs me," says he, "that, when cruising in the Cornwallis, amidst the Philippine islands, he has more than once seen, after those dreadful hurricanes called typhoons, floating islands of *(matted)* wood, with trees growing upon them; and that ships have sometimes been in eminent peril, in consequence of mistaking them for terra firma." Mr. Lyell conjectures, not improbably, that by means of such an insular raft, or wandering Delos,—"if the surface of the deep be calm, and the rafts carried along by a current, or wafted by a slight breath of air fanning the foliage of the green trees, it may arrive, after a passage of several weeks, at the bay of an island, into which its plants and animals may be poured out as from an ark; and thus a colony of several hundred new species may at once be naturalized." Thus he accounts for the peopling of the volcanic and coral islands in the Pacific.

It must be borne in mind that nothing really happens by chance, or is the result of an accidental concourse of fortuitous events: second causes are always under the direction of the *first*, who ordereth all things according to the good pleasure of his will; and therefore the elevation of a new island from the bosom of the deep, whether immediately produced by volcanic agency, or by an earthquake, or built by Zoophytes, still may be denominated *his* work; so likewise the same Almighty Guardian of the universe, whose name is Jehovah of Hosts, directs all the actions and motions of the hosts that he hath created, to the full accomplishment of every purpose that, in his wisdom, he hath formed. When we are assured that the hairs of our head are all numbered, and that not a sparrow falleth without our Heavenly Father, we are instructed to look beyond second causes for the direction and management of events that appear at first sight the most trivial, but which, in their immediate or remote consequences, may be productive of effects that are important to be attended to and provided for.[1]

We know that when animals of any kind exceed certain limits, though beneficial in the ordinary exercise of their instincts, they become noxious. God alone knows when they approach these limits; it is he, therefore, that employs man or other animals to destroy a certain number of them, that they may bear a due proportion to other beings on which they act; or if he wills to punish mankind, he suffers their numbers to increase so as to answer this intention. But to all his hosts, he says, "*Thus far shalt thou go and no further.*" Therefore, when the ocean, or fires below its bed, or other causes elevate islands above its surface, it is he that conducts to them the population he intends should occupy them.

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[1] Appendix, note 15.

The islands of Bourbon and Mauritius both appear to be of volcanic origin: amongst their aboriginal animal inhabitants was a most extraordinary gallinaceous bird, called the Dodo;[1] this bird, like the ostrich and cassowary, had only rudiments of wings, and of course was unable to fly; being unfit for food, though of the gallinaceous order, and a very ugly and disgusting object, it soon became extinct in those islands, and the only remains of it are a leg and foot at the British Museum, and a skeleton of the head in the Ashmolean Museum at Oxford. It has been contended that this bird, having never been discovered elsewhere, was peculiar to these islands, but there are reasons for beleiving, that it was not the only species of its genus, for Latham has included in it two others,[1] both stated to have been found in African islands. This affords a strong presumption that the head quarters of the genus are on the continent of Africa, and that these three species have been conveyed to the islands they are stated to have inhabited by some accidental cause. By the direction of Providence, a floating island, like that seen by Captain Smyth, might be the means of conveying this and their other inhabitants to them.

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[1] *Didus ineptus.*

I think, therefore, that there is no necessity to have recourse to a new and more recent creation, to account for the introduction of its peculiar animals into any given country.

The fact itself, that almost every country has its peculiar animals, affords a proof of design, and of the adaptation of means to an end, demonstrating the intervention and guidance of an invisible Being, of irresistible power, to whose will all things yield obedience, and whose wisdom and goodness are conspicuous in all the arrangements he has made. Wherever we see a peculiar class of animals we usually see peculiar circumstances which require their presence. Thus the Elephant and Rhinoceros, the Lion and the Tiger, are found only in warm climates, where a rapid vegetation, and infinite hosts of animals, seem to require the efforts of such gigantic and ferocious devourers to keep them in check: but on this subject I shall have occasion to enlarge hereafter.

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[1] *Didus solitarius* and *nazarenus*.

There is another point of view, illustrative of the Divine attributes in this partial location of various animals. If every region, or nation, contained within its limits the entire circle that constitutes the animal kingdom, and the remark may be extended to every natural object, how weak and trifling would be the incitement for man to visit his fellow-men. Were the productions of every country the same, there would be little or no temptation for commercial speculation, therefore the merchant would stay at home; the animal, and plants, and minerals would be the same, therefore the naturalist would stay at home; the astronomer indeed, and geographer, and the student of his own species, might be tempted sometimes to roam, but the ocean would be truly *dissociable,* and those ties that now connect the different nations of the globe would, for the most part, be broken. They are now linked to each other, in a bond of amity, by the intercourse which their mutual wants produce, and the body geographical, if I may use such a metaphor, as well as the body natural, is so tempered, and so furnished in every part, that constant supplies of things, necessary or desirable, are uninterruptedly circulating, by certain channels, through the whole system; and thus keep up a kind of systole and diastole, which diffuses every where a healthy temperament, and is universally beneficial. It is, moreover, calculated to generate those kindly feelings which ought to reciprocate between beings inhabiting the same globe, and sprung from the same original father. And the cultivation of these feelings of mutual good will was, no doubt, the principal object of the Deity in the distribution of various gifts to various countries, endowing some with one peculiar production and some with another: so that one might not say to another, "*I have no need of you.*"

Herein is the Divine wisdom and goodness most conspicuous. Had chance, or nature, as some love to speak, directed the distribution of animals, and they were abandoned to themselves and to the circumstances in which they found themselves in their original station, without any superintending power to guide them, they would not so invariably have fixed themselves in the climates and regions for which they were evidently intended. Their migrations, under their own sole guidance, would have depended, for their direction, upon the season of the year, at which the desire seized them to change their quarters: in the height of summer, the tropical animals might have taken a direction further removed from the tropics; and, in winter, those of colder climates might have journeyed towards instead of from them. Besides, taking into consideration other motives, from casual circumstances, that might have induced different individuals belonging to the same climates to pursue different routes, they might be misled by cupidity, or dislike, or fear. On no other principle, can we explain the adaptation of their organization to the state and productions of the country in which we find them—I speak of local species—but that of a Supreme Power, who formed and furnished the country, organized them for it, and guided them into it.

There is another question relating to local animals which here requires some notice. Are they really distinct species? Have not the characters which separate them from their affinities been produced, in the course of years, by peculiar circumstances in which they are placed, such as climate, temperature, nature of the country, food, and the like? Every person who knows any thing of the history of animals must admit, that great changes do take place in them from the long action of these causes. For instance, some varieties of the common ox are polled, having only rudiments of horns; others have very short and others very long ones; in some they are not fixed to the skull, but attached to the skin, and moveable with it. The same thing, likewise, takes place with sheep; some have no horns, others have two, and one breed, the Icelandic, is distinguished by having four. How these variations have been produced, and by what circumstances they are ruled, has not been ascertained, nor what differences, in other respects, obtain between the armed and unarmed varieties. Linné indeed observed, with respect to the polled sheep, which he denominates English sheep,—but whether they are strictly entitled to that name is not clear, for in the pillars of Trajan and Antoninus, though there are no polled oxen, there are polled sheep,—that their tails and scrotum reach to the knees; but this does not appear a certain and invariable fact. A young zoologist, when his attention is first arrested by these facts, will probably be inclined to think that animals, exhibiting such striking differences, cannot belong to the same species; but in the progress of his experience, especially in what takes place in almost all animals that man has taken into alliance with him, he will see reason to change his sentiments.

Again, the ears of some animals also exhibit differences that might seem to indicate specific distinction. We see this both in the horse and the swine. In the wild horse the ears lie back, in the domesticated or cultivated one they are erect. The horse was not originally a native of America; but when the Spaniards and other nations obtained a footing in that country, they carried this animal with them, which is now become wild, and numerous herds of them are found in the Llanos, these generally, we are told, are of a chestnut bay, and have recumbent ears. Those that are found wild in the Steppes of Tartary, have the hair of the mane and tail very long and thick, and their ears also are recumbent. A writer, quoted below, has concluded from some observations of Xenophon and Varro, that the military horses of the Greek and Roman republics were much nearer those in the wild state, as just described, than in a subsequent period.[1] In all the war horses, however, sculptured in Trajan's and Antoninus' pillars, the ears are erect, as I think also are those of the Elgin marbles in the British Museum—at least, none of them appear to be recumbent; and in some figured in Hamilton's *Ægyptiaca*,[2] from sculptures at Medinet Abou, in Egypt, which are still more ancient, the ears of all are erect.

In England we have two breeds of swine, one with large flapping or pendent ears; of this description are those fattened in the distilleries in and near London; the other with small, erect, acute ears, common in the county of Suffolk.

When it is considered, that the varieties of the above animals with erect ears appear to exhibit altogether a better character, if I may so speak, than their less spirited brethren, whose ears are pendent or laid back, and that this circumstance seems to indicate some approach to civilization in them; it may, probably, be deemed to result from some developement of the brain produced by education, and present some analogy to the effects of the latter in the human species.

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[1] Roulin. *Anim. Domest. Ann. Des. Sc. Nat.* xvi. 26.

[2] Pl. viii. ix.

There is a certain protuberance growing on the back, between the shoulders, and consisting chiefly of fat, which distinguishes the Indian oxen, both the larger and smaller varieties, from our own, which is known sometimes to attain to the enormous weight of fifty pounds; the ox of Surat is stated to have two of these bosses, or humps. Now, Burckhardt has observed, with respect to the camel, that—"While the hump continues full, the animal will endure considerable fatigue on a very short allowance, feeding, as the Arabs say, on the fat of its own hump. After a long journey the hump almost entirely subsides, and it is not till after three or four months' repose, and a considerable time after the rest of the carcass has acquired flesh, that it resumes its natural size of one fourth of the whole body." This conjecture of the Arabs may, very probably, be well founded, for it is known that animals which become torpid in the winter, are very fat and have several cauls abounding in that substance; but when they awake from their long repose in the spring, they have absorbed a large proportion of it, and are comparatively lean, and more fit for action. During their torpidity the fat is absorbed into the system by means of the lymphatic vessels and the ramifications of the veins. It is stated, however, that the Bear comes out of its winter-quarters as fat as it went into them, but that in a few days, it becomes very lean.[1] In this case it would seem as if there was little or no absorption during hybernation, and that it becomes very rapid upon the animal's emersion from its hiding place.

Reasoning from analogy, the hump on the Zebu may have some such use, and during the dry season, when the food is scorched up, may minister to the nutriment of the animal. If this be the case, this variation from the common type is evidently designed, and furnishes a proof of the care of the Creator for all his creatures, and likewise of such an adaptation of means to an end, as evince both the wisdom, power, and prescience of Him who has so arranged circumstances and agents in every climate as to fulfil his benevolent purposes.

The allwise Governor of the universe, when he gave to the sheep its covering, appears to have had in view not solely the protection of the animal from the effects of cold, but more particularly the benefit of him whom he had enthroned at the head of his creation, by thus placing at his disposal a material so inestimable, for his use and comfort, as wool. It has been observed that all the wild sheep are clothed with long hair; but the Guinea sheep,[1] which is found in the tropical countries, both of Africa and India, is the most truly hairy of any, evidently a provision of the Author of nature, suited to the climate in which they are found. The fine fleeces of the cultivated breeds appear to have been engrafted, as it were, on the long hair of the wild ones, which, doubtless, have been very much improved by the attention paid by man to his flocks. The influence of climate, the quality of pasturage, a due supply of wholesome food in winter; and washing and shearing when summer approaches, have all, certainly, contributed to the improvement of this staple of our commerce. But it was God who endowed these animals with those facilities, if I may so speak, of which man availing himself, might produce by culture the valuable article, in its highest perfection, of which I am here speaking. What a difference between the hair of the Guinea sheep, and the beautiful fleece of the Merino, which even seems to be exceeded, in fineness and softness, by the straight wool of the Parnassian breed.

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[1] Dr. Richardson, *Faun. Boreali-Americ.* i. 16, 20.

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[1] *Ovis aries africana.*—L.

No animal, if indeed all belong to one original species, varies more than one that is most domesticated of any, the dog: some, as the water-dog,[1] being covered with curled hair almost as thick as the fleece of a sheep, while others, the Turkish-dog,[2] are absolutely naked; others again, the grey-hound,[3] being very slender, with long slender muzzle and legs, remarkable for their velocity and the quickness of their sight; others lastly, the hound,[4] more robust in form, less swift in motion, with a short obtuse muzzle, depending chiefly upon their scent in pursuit of their prey. Whoever studies all these supposed varieties, and the diversified functions which they exercise in our service, as our faithful and attached companions, the watchful guardians and defenders of our property, the purveyors of our table, and the ministers of our pleasures, must acknowledge the wisdom, goodness, and power of the Creator in the production of so versatile a race, applicable, in so many ways, to such a variety of purposes, many of them of the first importance. Without them some nations would have no means of conveyance from place to place;[5] and others would scarcely be able to supply themselves with a sufficiency of food.[1]

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[1] *Canis familiaris aquaticus.*

[2] *Canis familiaris ægyptius.*

[3] *Canis familiaris graius.*

[4] *Canis familiaris molossus.*

[5] The Kamtchadales.

Amongst the birds there is one tribe peculiarly domesticated, which likewise is subject to numerous variations (it will be readily seen that I allude to our common poultry), but the differences that obtain in them are chiefly confined to their plumage; some are crowned with a tuft of feathers; others, as the Friesland-hen, have the feathers on their body recurved; another breed, as the rumplets, have no tail; the generality have their legs naked, but the bantams have them covered with feathers; and, to name no more, the silk-hens, instead of feathers, are clothed with a kind of silken hair.

We cannot state the object of all these differences, but probably it is connected with the climate and other circumstances of the country in which they were produced. India and its islands appears to be the metropolis of this valuable species of fowl, and the jungle fowl is supposed to be the original breed; but this is one of those animals which will live and thrive in every climate except the Polar; and when we consider the benefits we derive from them, we shall be disposed with grateful hearts to adore and glorify our Almighty benefactor, who fitted them, as well as so many other useful animals, to become, like ourselves, denizens of the whole earth. It is a remarkable circumstance, and worthy of particular attention, that the animals most subject to variation, are chiefly those which man has taken into alliance with him from their adaptation to his purposes. Now this tendency to vary multiplies their uses, or, at least, contributes to fit them for following him into different climates, enabling them to accommodate themselves gradually to any change of circumstances to which they may therein be exposed, without diminishing their utility.

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[1] Many of the North American Indians, Esquimaux, &c.

Amongst the other races, especially the feline, this appears not to take place, at least only with respect to colour. The cat, though every where domesticated, exhibits no other differences than what obtain in the colour of her fur. If we recollect that this favourite quadruped is principally employed to destroy those minor animals that are noxious in and about our houses, to which indeed her instinct impels her, and that she is solely led by that instinct, and adds nothing to it from instruction, her sole savage object being, like that of her congeners, to seize and devour her prey; that she never assists man, like the dog, as the companion of his sports in various ways, but exercises her single function always in the same way, and under the same influence: if we further recollect that these are the general habits of the genus to which she belongs, which appear subject to very trivial modifications from altered circumstances, and that almost all animals that do not follow in the train of man are equally constant, we may hence infer that the Creator has not gifted them with the capability of improvement, and the developement of latent qualities not apparent in their wild state.

There is one circumstance, however, in which predaceous or carnivorous animals, when domesticated, shew some aberration from their instinct, they do not refuse farinaceous food. The cat and the dog will both eat bread with great eagerness and thrive upon it.

It has been questioned by some whether the present races of animals have not all, in the lapse of ages, undergone some alterations from the primitive types. The only way by which this can be at all ascertained is by consulting the oldest descriptions of them, and the oldest sculptures; and these, I think, will prove that no such alteration has taken place.

In considering the general distribution of animals we may further remark that some are stationary, while others, at certain periods, migrate or shift their quarters from one climate or region to another.

In considering the former, I shall not here enlarge on the stations of the different tribes further than as they are connected with the great object, which it is my duty to illustrate. With respect to many it may be observed, that though perhaps widely dispersed, yet they have their metropolis.[1] Thus the gigantic whales, though they are sometimes found in low latitudes, not, however, within the tropics, yet their grand rendezvous is in the arctic and antarctic seas; furnishing a strong proof that in these they find the greatest supply of their appropriate food. The giant terrestrial Mammalia, on the contrary, confine themselves to intratropical regions, where the luxuriance of vegetation best corresponds with their enormous consumption of food. Amongst the birds the Vulture, though one species, the Lammer-Geyer,[2] comes as far north as the Swiss Alps, generally most abounds in hot climates, and is often of essential service in preventing the infection, likely to be produced by putrid animals; to these birds our Saviour's words, doubtless, allude, "*Wheresoever the carcass is, there will the eagles be gathered together;*" the species he had in his eye, was probably the Egyptian Vulture,[3] the services of which in Egypt are strikingly described by Hasselquist. After noticing its disgusting appearance, he says: "Notwithstanding this, the inhabitants of Egypt cannot be enough thankful to Providence for this bird.

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[1] *See Introd. to Ent.* iv. *Lett.* xlix.

[2] *Vultur Barbatus.*

[3] *Vultur percnopterus*, L.

All the places round Cairo are filled with the dead bodies of asses and camels; and thousands of these birds fly about and devour the carcasses, before they putrify, and fill the air with noxious exhalations." Belon observes, which proves their prevalence there, that in Palestine they devour an infinite number of mice, which would otherwise be a great pest. The cognate tribe, the eagles, though they are widely dispersed, have their metropolis in more northern climates, and are distinguished also from the vultures, by making living animals chiefly their prey: for this they are gifted with a wonderful acuteness of sight, and indomitable strength of wing, and of legs and talons, fitting them for astonishing velocity of flight, and for resistless force, when they attack and bear off their prey. As they have no scent, their eyes are of infinite use, and enable them to discern a small bird at an almost incredible distance: and often to get a clearer view and more extensive horizon, when they leave their mountain aeries, they ascend to a great height. M. Ramond, when he had ascended the highest peak of the Pyrenees, saw an eagle soaring above him, flying directly in the teeth of a violent south-wester, with inconceivable velocity.

Another genus of a tropical type, but not confined to the tropics, forming a striking contrast with the gigantic forms last adverted to, consists of the numerous species of the brilliant and diminutive Humming birds, which like the butterflies, whose analogues they are, suck the nectar of the flowers. This, strictly, American genus is in great force, also without the tropics, for they abound in Mexico, and go northward as far as Canada, and southward as far as Patagonia. There is no northern metropolis for any analogous form, to these living gems, which constitute the ornament and life of the new world. But the old shares with the new, in another beautiful type in the winged creation, I mean the Psittaceous or Parrot tribes, which chiefly support themselves upon fruits, and abound in all tropical countries, these the Creator has not only invested with the gayest colours and plumage, but gifted also with the power of speech, at least of imitating the speech of man, when brought into contact with him. Their principal residence is within the tropics, but not confined to them, as many are found in New Holland. The Aras[1] are confined to the new world, and one of its greatest ornaments; their plumage being the most brilliant of any of the Psittaceans.

An analogous tribe of mammiferous animals inhabits the same station, and feeds on the same food with the parrots, these are what Zoologists call the Quadrumanes, or Four-handed beasts, from their often using their hind as well as their fore feet as hands, and many of them even their tail. This tribe includes the Monkeys, Apes, and Baboons, and though these do not imitate man, by catching his *phrases*, like the birds last named, yet they mimic all his *actions*. I have often thought, when I have examined figures of this tribe, that their features are typical of the different kinds of face observable in the human species: as far as relates to *body* they approach us, but in the *spiritual* part of our nature, elevated by high expectations, and by knowledge not confined to this globe on which we tread, but traversing the heavens, and penetrating in thought to the throne of Him who sitteth upon them, we infinitely exceed them.

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[1] *Macrocercus.*

Those animals that are of a predaceous or carnivorous character, are more widely dispersed, than many of the herbivorous ones, in fact they are co-extensive with their food, I do not mean specifically, but generically. Though the Lion and the Tiger, and the larger feline animals are generally tropical, yet the Cat is naturalized every where. Though the Hyæna and the Jackal shrink from the temperature of the greater part of Europe, yet Wolves and Foxes, as well as the great majority of the canine race, are found indigenous, or have been formerly indigenous, in almost every part of it.

Many more instances might be adduced proving that animals have been placed originally in certain stations, adapted to the habits resulting from their organization and general structure, from which some of them have sent forth their colonies far and wide, while others, owing to peculiarities in these respects, requiring a given temperature and kind of food, or to local obstacles stopping their further progress, have not wandered beyond certain limits.

Having, in the preceding pages, endeavoured to account for the dispersion and present stations of the various members of the animal kingdom at large, not to leave the subject incomplete, I must next make a few observations relative to that of the human race.

It has been a favourite theory of some modern physiologists that God "*hath* not *made of one blood all nations of men for to dwell on all the face of the earth*," but that there are different species of men as well as of animals: others, who do not go quite so far, suspect—that at the last great deluge, besides Noah and his family who were saved in the ark, some others escaped from that sad catastrophe by taking refuge on some of the highest mountain ridges of Asia and Africa, and seem to insinuate that from these arose the three principal races, the Caucasian, the Mongol, and the Negro, that now hold possession of our globe.[1] I shall say something in controversion of each of these theories, beginning with the last.

This indeed furnishes a clue for its own refutation, since it admits *three* principal stems, which is in accordance with the Mosaic account, that from the families of the *three* sons of Noah, the nations were divided in the earth after the flood. The author of the above theory seems disposed to admit the truth of the Mosaic account, but insinuates that it may have been only intended to instruct the Israelites in the history of the race to which they belonged, while that of other races may have been passed over in silence. It is too much the fashion, in this sceptical age, to evade the facts that are most clearly revealed in scripture, by saying the language must not be taken strictly nor interpreted literally, even when it is concerning events in which there is no room for metaphor. One would think that the terms in which God foretold the deluge were of this description. "*And behold I, even I, do bring a flood of waters upon the earth, to destroy* all flesh *wherein is the* breath of life *from under heaven; and* every thing *that is in the earth shall* die." And again—"*And the waters prevailed exceedingly upon the earth, and all the* high hills *that were under the* whole heaven *were covered: fifteen*

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[1] Outlines of Hist. *Cab. Cycl.* ix. 4.

cubits upwards *did the waters prevail, and the* mountains *were covered.*" It is also stated *that every living substance, both man and cattle,* &c., *was destroyed from the earth, and that Noah only remained alive, and they that were with him in the ark.* Can language be more definite and express?

What can be more absurd than that an ark should be necessary for the saving of Noah and his family, and a world of animals, to be stored with a vast supply of provision, when they might have escaped according to this hypothesis by taking refuge on the summit of some lofty mountain to which Divine Wisdom might have directed them?

There is no occasion whatever for such an Hypothesis to account for the dispersion of mankind and their breaking into nations. Two chapters in the book of Genesis[1] set the whole matter in a clear light, both as to the first cause of their separation, and the various tribes into which they separated, in which we can trace the names of many nations still in existence. From Babel each in due time took the course, in that direction, however led by circumstances, that Providence had decreed. Europe became at last the head quarters of the descendants of Japhet, Asia of those of Shem, and Africa of those of

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[1] Chap. x. xi.

Ham; the Shemites in the lapse of ages, passing over to America, were the progenitors of the red or copper race of that continent. Nor were there any insurmountable obstacles in the way to prevent the peopling of the globe from one common stock. Supposing Babel or Babylon to have been, so to speak, the centre of irradiation—how easy was the transit for Ham's descendants into Africa by the Isthmus of Suez; into Europe, the path was still more open for those of Japhet; and as the stream of population spread to the East, the passage to America was not difficult to those who had arrived at Behrings Straits. But in all these countries mixtures with the aborigines have probably taken place, either from the irruption and colonizations of great conquerors, the spread of commerce and similar causes, which naturally tend to produce variations in races from the primitive type. Hence writers on this subject now reckon six races distinguished by their colour, viz. a white race; a tawny race; a red race; a deep brown race; a brown-black race; and a black race.

This leads me to the other theory alluded to above, that there are different species of men as well as of other animals. The principal foundation upon which those naturalists have built their theory, that have adopted the opinion, that there are several distinct species of men originally created, is not only their colour, but likewise certain parts of their structure, which are found to vary in different races, such as the shape of the head; the prominence, more or less, of the jaws, producing different facial angles; the comparative length of some of the bones, and shape of the feet; the degradation of intellect; the peculiar acuteness of the senses; the tenacity of the memory; and, to name no more, the appropriation of a peculiar species of parasitic animal to a peculiar race.[1]

Various are the circumstances, which, in the progress of generations, tend to produce differences between the different races which are now found inhabiting our globe, without having recourse to a theory that boldly contradicts or nullifies the word of God; since the Scripture expressly declares, that God "*hath made of one blood all nations of men, for to dwell on all the face of the earth, and hath determined the times before appointed, and the bounds of their habitation.*" Climate, the elevation of country, its soil, waters, woods, and other peculiarities; the food, clothing, customs, habits, way of life, and state of civilization, often, of its inhabitants, produce effects upon the latter that are important and durable, and contribute to impress a peculiar character upon the different races of men as well as animals, that inhabit our globe, and will account for many distinctions, which indicate that such an individual belongs to such a people. But these circumstances will not explain and satisfactorily account for all the peculiar characters that distinguish nations from each other, without having recourse to the will of a governing and all-directing Power, influencing circumstances that happen in the common course, and, according to the established laws of nature, to answer the purposes of his Providence. When he confounded the speech and language of the descendants of Noah, congregated at Babel, he first made a division of mankind into nations; "*And from thence did Jehovah scatter them abroad upon the face of all the earth.*" The same Divine Power that effected this distinction, which may be called the origin of nationality, also decreed that nations should be further separated by differences of form and colour, as well as speech, which differences originated not in any change operated miraculously, but produced by *second* causes, under the direction of the First. When we are told expressly that "*The hairs of our head are all numbered,*" and that in God's "*Book all our members are written,*" we learn, what in common parlance we acknowledge, that it is according to God's will that we are made so and so. That persons, who, in some one or other of their parts and organs, exhibit an approximation to races different from that to which they belong, as thick lips, a prominent facial angle, a difference in the relative proportion of certain bones to each other, the curling of the hair, and the like, occur in all places, must be obvious to every one who uses his eyes and intellect. It is evident that all these variations are produced by circumstances that we cannot fully appreciate. Even in animals, there is as much difference in general characters between the Arabian steed of high blood, fine form, indomitable spirit, and winged speed, and the brewer's dray-horse, of a strikingly opposite character, as there is between the European high-bred gentleman and the African negro. The long-legged swine of France, though exhibiting such a marked difference in the relative length of some of their bones, are still the same species with the short-legged swine of England. The same argument is strengthened by the infinite varieties of the dog, the erect ears of the tame, and recumbent ones of the wild horse.[1] It is evident, therefore, from fact and from what ordinarily happens, that there are powers at work at and after conçeption, and while the fœtus is in the womb, that can produce variations in the same people, approaching to those that distinguish the Negro, the red man, or the brown man ; which, indeed, can produce forms much more singular and extraordinary; for instance, the monsters that sometimes make their appearance in the world; as the Siamese youths, children with two heads, &c. The mysterious influence that the excited imagination, or passions, or appetites of the mother, have over the fœtus in her womb, is well known, and produces very extraordinary consequences, and malformations, and monstrosities. When we consider that all these facilities, if I may so speak—these tendencies to produce variations in the fœtus, are at the disposal of Him, who upholds all things by the word of his power, and turns them to the fulfilment of his own purposes,—we may imagine that thus new types may be produced, which may be continued in the ordinary way of generation; according to that observation of Humboldt, that "The exclusion of all foreign mixtures contributes to perpetuate varieties, or aberrations from the common standard."[1] That what at first were family characters, accompany the race when grown into a nation, is evident from the case of the Jews, who, wherever dispersed, exhibit certain common characters by which they are every where known; and, with respect to complexion, they are said to vary according to the climates in which they reside. A singular exception to this is furnished by the black Jews of Malabar, mentioned by Dr. Buchanan. At Cochin, he says, there are two classes of Jews, the white and the black Jews. The latter are supposed to have arrived in India soon after the Babylonian captivity; at least, they have that tradition amongst them, which seems confirmed by the fact that they have copies only of those books of the Old Testament which were written previously to the captivity. The white Jews emigrated from Europe to India in later ages. Now here is a singular fact, that in the lapse of so many ages a white or tawny race has become black. Mr. White endeavours to account for such an aberration from his principle, that colour does not result from climate, by an observation not altogether founded in fact—namely, that the Jews have gained proselytes in every country in which they have resided, and, being at liberty to marry those proselytes, this would produce mixed breeds. But though the Jews, in our Saviour's time, would compass sea and land to gain one proselyte, this has not been their character since the destruction of Jerusalem, and we never hear now of their making proselytes. Indeed, these black Jews of Cochin seem to have been settled there long before any white ones came to that place.

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[1] See N. Dict. D'Hist. Nat. xv. 150, Article *Homme*. White's *Regular Gradation in Man*, &c. S. 2.

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[1] See above, p. 60.

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[1] Personal Travels, v. ii. 565.

With regard to the degradation of the intellect, and the peculiar acuteness of the senses or memory of certain races; these furnish no proof whatever of specific distinctions, or that they could not be descended from the common ancestor of our species.

Humboldt has an important observation which will explain how this might happen without having recourse to such a supposition. Speaking of the barbarism of certain tribes of Americans and Asiatics, he observes:—"The barbarism that prevails throughout these different regions is, perhaps, less owing to a primitive absence of all kind of civilization, than to the effects of a long degradation. The greater part of the hordes, which we designate under the name of savages, descend, probably, from nations more advanced in cultivation."[1] And in another place:—"If it be true that savages are for the most part degraded races, remnants escaped from a common shipwreck, as their languages, their cosmogonic fables, a crowd of other indications seem to prove."

Now, what is it that degrades man, and causes him to make an approach towards the brute? Setting up sense above reason and intellect; sight above faith; this world above the next. Experience teaches us, that those faculties of our nature that are most cultivated, become most acute: if intellectual pursuits are neglected, the intellect itself becomes weakened; in proportion as the senses are exercised, they are strengthened; in proportion as the pleasures they afford us stand high or low in our estimation, we graduate towards the brute, which knows no pleasures but those of sense, or towards the angel who knows no pleasures but what are spiritual. There is a governing principle in man,[1] originally enthroned in him by his Creator, and to whose sway the senses were originally in complete subjection. But when man fell, a struggle was generated, the lower or sensual part of his nature striving to gain the rule over him, and to dethrone the higher or intellectual. This is the "*law in our members warring against the law of our mind,*" mentioned by the Apostle. Now, we know that the same individual, at different periods of life, may be directed in his actions first by one and then by the other of these laws; he may begin in sense, and end in spirit, or vice versâ. If the former takes place in him, his nature and character are elevated, and he is become more intellectual; if the latter, they are degraded, and he is become more sensual and nearer to a brute, and yet in both cases he remains the same man as before; his species is not altered. Apply this to nations, will it follow, because one is now generally gifted with a greater degree of intellect, and another remarkable for more acute sensation, that, therefore, they cannot be derived from a common origin? Nations are often led by custom as well as individuals; they, therefore, usually walk in the path that their ancestors have trod before them, and, from circumstances connected with this, it happens that some apply their faculties to higher pursuits than others. Those that chiefly cultivate the intellect improve it by that very act; while those who are principally engaged in pursuits that require the constant and skilful use of the organs of sensation acquire a degree of expertness in that use not to be met with in the others; but the intellect being employed only upon low objects, becomes habitually degraded, and loses all taste for things that are not visible and tangible. Though in an individual, or in a long succession of individuals, this might not produce a perceptible contraction and non-developement of the organ of the intellect, or in the chamber that contains it; yet, in the lapse of ages and generations, this effect would gradually be produced, for if an organ is not used for a long course of years, it becomes contracted, and from long habit unapt to perform its natural functions. Some American nations, by the application of boards properly shaped, depress the skull-bone of their infants, thinking a flat head a great beauty, whence the tribe is distinguished by the name of Pallotepallors, or Flat-heads. Others, by the same means, give them a conical form; there is no difficulty, therefore, in conceiving that with a gradual contraction of the brain, that of the skull might take place in the fœtus, which would accommodate one to the other. With regard to the memory, it is not wonderful that a being who occupies his time and intellect with few objects, should have a more distinct recollection of certain events, than one whose attention is more divided. It may be observed of the lower orders in general, that their memory, for the same reason, of matters within their own sphere of comprehension, is often more clear than that of persons better educated and informed.

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[1] *Personal Travels.* E. T. iii. 208.

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[1] Το ἡγεμονικον.

I remember the case of a negro who resided near Bury St. Edmunds, who was an educated man, and published a volume of poems by subscription, which did him no discredit.[1] Hence, it is evident that there is a difference of capacity in negroes as well as whites, which admits of improvement from instruction and study, when they come among civilized people. Little stress will be laid on the parasite of the negroes,[2] being specifically distinct from that which infests the whites, when we reflect that the horse and the ox have different insect parasites and assailants in different climates. There is a time fixed upon in the divine counsels when the curse shall cease; and it will then be found that by reversing the course that has degraded so many nations, the apostacy, namely, from God to idolatries of the most debasing kind—which has yielded them up a prey to sensuality, clouded their understandings, and, instead of universal good-will, has taught them to regard those that are not of their own tribe or caste as objects of just hatred and injury—when this course has been reversed and they are brought back to God, which will take place in his time and at his word; and by the means and instruments that he empowers and commissions,[1] they will become more elevated in their character, and assume a higher rank among the nations: and they will make good their claim to the same inheritance with the other members of the Christian family. He who decreed the end, decrees also the means. *When the Lord gave the word, great was the company of those that published it.* This was the case at the first preaching of the Gospel, when the gross darkness of heathen idolatry covered the earth; this also was the case at what may be called its republication at the time of the Reformation, when the gross darkness of papal idolatry had almost put out the light of truth in the church; and so shall it be again, should another and perhaps last cloud of error envelope the world with darkness,[1] which seems even now beginning to gather, and may we not hope that it will be followed by that happy time, foretold by the prophet, when—*the knowledge of the Lord shall cover the earth as the waters cover the sea?* The old curse on Ham's offspring shall then cease, he shall no longer be a servant of servants to his brethren; then shall the curse also that has driven the children of Abraham after the flesh into every region of the globe, cease, and they shall look on him whom they pierced, and be restored to the favour of their God, and to their own land;[2] and next, in its own day, the original curse, also pronounced upon Adam and his posterity shall be obliterated and done away for ever.

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[1] He was called *Ignatius Sancho*.

[2] *Pediculus Nigritarum*.

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[1] See Appendix, note 16.

Taking all the circumstances I have noticed into consideration, I trust I have made it clear, that the variations observable in the different races of men are not of such a nature as to render it impossible, or improbable, that they should all have been derived from a common stock; and that the degradations observable in some of them, and approximation to the highest of the brutes, was caused not by the will and fiat of the Creator, but by their own wilful departure from him, and voluntary self-debasement. *Because they did not like to retain God in their knowledge, he gave*

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[1] See Appendix, note 17.

[2] See Appendix, note 18.

them over to a reprobate mind to do those things that are not convenient: further, that with respect to those characters, which distinguish one nation from another, they may be attributed to the action of physical causes directed by the Deity: who, to use the language of a pious and excellent poet,

> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent.

THERE is another interesting subject connected with the geography of animals, which may find its place here; a subject than which none shows more evidently or strikingly the hand of a beneficent and ever watchful Providence, holding the reins; and upon certain occasions and at certain seasons, directing various animals to change their quarters, and seek often in distant countries a more genial climate, in which they may give birth to their young, or find a better supply of food for their own support. I shall, therefore, now devote a few pages to the *migrations* of animals.

The most general principle that causes emigration is common to man and animals. When a country is over-peopled, and can no longer maintain its inhabitants, unless some means can be devised at home, by which the pressure may be lightened, and the suffering classes enabled to procure the necessaries of life, there must inevitably be some outbreak; when the rivers can no longer be contained within their natural channel they will overflow, and spread desolation around, till they have passed away and found a place in the great receptacle of waters. Thus, in ancient times, the great northern hive sent forth its numberless swarms, and overturned and divided amongst them a considerable portion of that mighty empire which extended its iron sway over the fairest portion of the globe.[1]

With regard to their migrations, animals may be divided into two classes. The first will consist of those that migrate *casually*, under a certain pressure; and the second of those that migrate *periodically*, or at certain seasons.

1. Of the first description, are those infinite armies of Locusts, which, when they have laid bare one country, as an overshadowing and dark cloud pregnant with the wrath of heaven, pass on to another; mighty conquerors of old, of whom they were the symbols, from Sesostris to Sennacherib and Nebuchadnezzar, also mark their progress by devastation and ruin; to use the graphic language of the prophet—"*The land is as the garden of Eden before them, and behind them a desolate wilderness.*"[2]

This plague has generally been considered as belonging to the old world, in which they seldom exceed latitude 42°. but in N. America, there is a species of Locust or Grass-hopper, as Dr. Richardson informs me, according to the report of the Indians, becoming prevalent about once in twenty years, which committed great devastations at lord Selkirk's colony of Red river, as high as latitude 52°. They made their first appearance in vast flights coming from the plains to the westward, and soon destroyed the crops of grain, and every thing green. They re-appeared for three or four successive summers, each year in smaller numbers, and now for several years they have not been seen.

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[1] See Appendix, note 19.

[2] See on the Locusts *Introd. to Ent.* 1 Lett. vii.

These were evidently insects of the same order and tribe with the locust, though perhaps of a different genus; but, probably the tradition of the Indians might relate to another North American devastator, which is also called there the Locust, but belongs to a genus beloved by the Greeks for its song, and hated by the less imaginative Romans for its stunning noise, which may be called the Tree Locust; a species of which is said to appear, about once in every seventeen years,[1] in such prodigious numbers as to do incalculable damage to the fruit and forest trees, in which it deposits its eggs, and upon which it feeds internally in the grub state, but the oral organs of the perfect insect are only calculated for suction.

Amongst quadrupeds, the analogues, in some respects, of the locusts, are the *Lemmings*, a kind of mouse or rat. These little animals, which usually inhabit the mountains of Norway and Lapland, in certain seasons, emigrate in prodigious numbers to the south; the most common species[1] is said not to lay up any winter store, but to form burrows under ground in summer, and under the snow in winter in search of food; but that found in Kamtschatka,[2] which is larger than a rat, is stated to be occupied during the summer in laying up provisions for the winter in holes under the turf divided into compartments, they consist of various kinds of roots, some even poisonous, but which agree with this animal, and of which it collects from twenty to thirty pounds. It is called in Kamtschatka Tegulchitch. In fine weather its instinct teaches it to spread its harvest of roots in the sun to dry and fit them for keeping. When these different species of Lemmings make their excursions, which take place only in certain years and seasons, and in different directions, the species last mentioned going towards the west, the others towards the south, like certain ants, they always march straight forward, neither turning to the right hand nor to the left, and if their course is interrupted by a river, they cross it by swimming. The common Lemmings, when they migrate, are regarded as a terrible scourge; they devastate the fields and gardens, ruin the harvest, and only what is kept in the houses escapes them, into these happily they never enter. Their number is so prodigious, that, when they die, the air is infected, and much sickness is the consequence. All this tribe of mice appear to live on roots, bulbs, grain, nuts, &c. and have generally a very short tail.

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[1] *Cicada septendecim*.—L.

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[1] *Lemmus vulgaris.*

[2] *Lemmus œconomus.*

The Campagnol,[1] or short-tailed rat of Pennant, is equally destructive; in some years their numbers are so prodigious, that they overflow, as it were, a whole district, and by their ravages produce famine and desolation. This effect is stated to have been produced in certain parts of France where an extent of forty square leagues was devastated by them. In their progress these animals are preyed upon by the predaceous quadrupeds and birds, by whose incessant attacks their numbers, in ordinary seasons, are kept within the bounds assigned them by the Creator, as are the Locusts by the Locust-eating Thrush,[2] and the Aphides or Plant-lice which may be denominated the Locusts of Britain, and which are stated sometimes almost to darken the air, by the lady-birds and aphidivorous flies.

All these migrations are produced by a different cause from those periodical ones which take place, after certain intervals, or at certain seasons, in various other animals of every grade; and though a scarcity of food, or straitened circumstances or accommodations may be the impelling motives, yet these are produced by an unusual increase in the numbers of the migrating species, so that they are driven to seek an outlet by which their supernumeraries may pass off and relieve them from the pressure, or the whole population, deserting an exhausted country, may establish themselves in better quarters.

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[1] *Arvicola arvalis.*

[2] *Turdus gryllivorus.*

In all the instances that I have here adduced, the object, at the first blush, as far as the Deity may be supposed to be concerned in these outbreaks, appears rather punitive than beneficent, but when we dip below the surface, and look to ultimate consequences, what appears to be altogether an evil, instead of a dark side, turns round and shews one bright with good. It is true, in some cases, the object is punishment of an offender, and in hopeless cases, the sentence is pronounced, "*Cut it down, why cumbereth it the ground.*" But before this, Divine Mercy, which willeth not that any should perish, employs those correctives, which at the same time that they give pain, and wear the appearance of evil and punishment, tend to produce that change of the mind and conversion of the heart, that will reconcile the sinner to God, and ensure to him the blessed inheritance of his children. But temporal good, as well as spiritual, is often the result of these visitations, the devastations of which they are the instruments, as was observed by Sparrman of the locusts, are often followed by fertility, and the fearful scourge is replaced by Amalthea's horn.

2. We are next to consider those migrations that take place periodically, and usually at certain seasons of every year; the general intention of which appears to be a supply of food, and often a temperature best suited to reproduction. Providence, in this, taking care that their instincts shall stimulate them to change their quarters, when these two objects can be answered at the same time, and by a single removal.

In North America, that ferocious and lion-like animal, the *Bison*,[1] called there the *Buffalo*, forms regular migrations, in immense herds, from north to south, and from the mountains to the plains, and after a certain period returns back again. Salt-springs, usually called salt-licks or salines, found in a clay, compact enough for potter's clay, are much frequented by these animals, whence they are called Buffalo salt-licks. Dr. Richardson informs me that the periodical movements of these animals are regulated almost solely by the pastures: when a fire has spread over the prairies, it is succeeded by a fine growth of tender grass, which they are sure to visit. How the Bison discovers that this has taken place seems not easily accounted for; perhaps stragglers from the great herds, when food grows scarce, may be instrumental to this.

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[1] *Bos Americanus.*

The Musk Ox, a ruminating animal between the ox and sheep,[1] has the same habit, extending its migratory movements as far as Melville, and other islands of the Polar sea, where it arrives about the middle of May, and going southward towards the end of September, where it has been seen as low as lat. 67° N., which, as Dr. Richardson states, approaches the northern limit of the Bison: its food, like that of the Rein-deer, called in North America the Caribou, is grass in the summer and lichens in the winter. Its hair is very long, and, as well as that of the Bison, which has been manufactured both in England and America into cloth, might be woven into useful articles. This animal inhabits strictly the country of the Esquimaux, and may be regarded as the gift of a kind Providence to that people, who call it *Oomingmak*, and not only eat its flesh but also the contents of its stomach, as well as those of the Rein-deer, which they call Norrooks, which consisting of lichens and other vegetable substances, as Dr. Richardson remarks, are more easily digested by the human stomach when they are mixed with the salivary and gastric juices of a ruminating animal.

The wild Rein-deer in North America, in the summer, as the excellent man and author lately mentioned states, seek the coast of the Arctic seas: it is singular that the females, driven from the woods by the musquitos, migrate thither before the males, generally in the month of May (some say in April and March), while the latter do not begin their march till towards the end of June. At this time the sun has dried up the lichens on the Barren Grounds, and the moist pastures in the valleys of the coast and islands of the above seas afford them sufficient food. Soon after their arrival the females drop their young. They commence their return to the south in September, and reach the vicinity of the woods towards the end of October. After the rutting season, which takes place in September, the males and females live separately; the former retire deeper into the woods, while the pregnant herds of the latter remain in the skirts of the Barren Grounds, which abound in the rein-deer[1] and other lichens. In the woods, they feed on lichens which hang from the trees, and on the long grass of the swamps. The males do not usually go so far north as the females. Columns, consisting of eight or ten thousand of these *Caribous*, so numerous are they in North America, may be seen annually passing from north to south in the spring, infested and attacked in their progress by numbers of wolves, foxes, and other predaceous quadrupeds, which attack and devour the stragglers.

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[1] *Ovibos moschatus.*

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[1] *Cenomyce rangiferina.* Achar.

The *Pronged-horned Antelope,*[1] as well as the Rein-deer, appears to go northward in the summer, and return to the south in the winter.

Dr. Richardson remarks to me in a letter,—"The Musk-ox and Rein-deer feed chiefly on lichens, and therefore frequent the Barren Lands and primitive rocks, which are clothed with these plants. They resort in winter, when the snow is deep, to the skirts of the woods, and feed on the lichens which hang from the trees, but on every favourable change of weather they return to the Barren Grounds. In summer they migrate to the moist pastures on the sea-coast, and eat grass, because the lichens on the Barren Lands are then parched by the drought, and too hard to be eaten. The young grass is, I suppose, better fitted for the fawns, which are dropped about the time the deer reach the coast." In all this we see the hand of Providence directing them to those places where the necessary sustenance may be had.

The same gentleman has remarked a singular circumstance with regard to the American Black Bear.[2] In general, this species hybernates in the northern parts of the fur countries; but it has been observed in certain years, and very severe winters, that great numbers enter the United States from the northward. These were all lean, and generally males. The natives assert, that a bear that is not fat cannot hybernate; therefore, those that have not acquired sufficient fat when winter overtakes them, necessarily emigrate to a milder climate.[1]

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[1] *Antilope furcata.*

[2] *Ursus Americanus.*

A migration of an animal of the *equine* genus was observed by Mr. Campbell in South Africa. The *Quagga*, a kind of wild ass, travels in bands of two or three hundred, in winter, from the tropics southward to a district, in the vicinity of the Malalaveen river, reported to be warmer than within the tropic of Capricorn, when the sun has retired to the northern hemisphere. They stay here for two or three months, which is called the Bushmen's harvest. The lions, who follow the quaggas, are the chief butchers. During this season, the first thing the bushman does, when he awakes, is to see whether he can spy any vultures hovering in the heavens at a great height; under them he is sure to find a quagga, which a lion has slaughtered in the night.

But the animals which are most noted for their migrations, from a cold to a warm climate, and *vice versa*, are the *birds*, which, as having dominion in the air, are enabled to transport themselves with greater ease, and with the interposition of fewer obstacles, than the quadrupeds, the theatre of whose motions is the earth, intersected by rivers and mountain ridges, which renders their periodical transit less easy to accomplish. The number of birds that migrate, if we take Dr. Richardson's scale, for those of North America, as a rule, compared with those that reside the whole year in a country, is about five-sixths, a very large proportion; but as the summer residents are replaced by winter ones, the difference is less striking, and the desertion less apparent and annoying. The celebrated Dr. Jenner, in a very ingenious posthumous paper, in the Philosophical Transactions for 1824, has produced many arguments to prove that the periodical migrations of birds are the result, not of the approach of the cold or hot seasons, but of the absence or presence of a stimulus connected with the original law, "*Increase and multiply*." That when they feel it they seek their *summer*, and when it ceases its action, their *winter* quarters. In one case, the animal winging its way to a climate and country best suited to the great purpose impressed upon it by its Creator, of producing and rearing a progeny; and in the other returning to a home, most congenial to its nature, and best supplying its wants.

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[1] *Faun. Boreal-americ.* i. 16.

The cause of emigration, in both cases, had previously been attributed to the changes of the temperature gradually produced by the change of seasons, and the growing scarcity of food resulting from it. But Mr. Jenner has observed that these cannot be the causes that occasion the migration of those birds that leave us early in the year, as the cuckoo,[1] which disappears in the beginning of July; and the swift,[2] which takes its departure early in the following month. At these times they can feel no cold blast to benumb them, and the food that forms their usual support is in the greatest abundance.

There seems to be some analogy between the birds that migrate annually to warmer climates to spend their winter, and those animals, which remaining in a country, seek a subterranean, or other close retreat, to shelter them from the rigours of that season, and in which they continue in a torpid state, till spring revives them and they issue from their hiding-places to fulfil the first law of their Creator. Several instances also are upon record, even with regard to birds that usually migrate, of their having been found torpid in the clefts and cavities of trees; and Spallanzani relates experiments which prove that swallows can bear a certain degree of cold when torpid. I do not recollect any observations which serve to prove that hybernating animals are regulated by the temperature as to the season at which they prepare to retire for the winter, except as to insects, which, with few exceptions, are of that description. My learned coadjutor, Mr. Spence, in our *Introduction to Entomology*, has some remarks on this subject, which seem, at first sight, to prove that the disappearance of insects, at least those of the *Coleoptera* order or beetles, is not preceded by any remarkable lowering of the temperature; on the contrary, he observed a great number of various genera congregating with this view when the thermometer was fifty-eight degrees in the shade.[1] This was about the middle of October. But there is one circumstance to which he has not adverted, which may tend to reconcile this fact with the received opinion. The nights, at this time of the year are often cold when the days are hot, the latter also are much shortened and the former lengthened, so that the sum-total of heat received from the sun is very much diminished, which may be the exciting cause of their hybernating at this time, when the diurnal temperature is so considerable.

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[1] *Cuculus canorus.*

[2] *Cypselus apus.*

With regard to the *swift*, these birds seem to avoid heat, they lie by in the middle of the day, and only appear in the morning and evening. Their early migration from this country may probably be caused by the heat; and Buffon says that instead of warmer, they seek colder climates. The house-swallow,[1] which remains with us till October, is stated to winter in Africa, so that its object is evidently a warmer climate. It is remarkable that the birds of this tribe, when they visit us in the spring, return to their old haunts. Dr. Jenner ascertained this by cutting off two claws from the foot of a certain number, several of which were found in the following year, and one was met with after the expiration of seven. The instinct that directs these little beings so unerringly across continents and oceans, and leads them to their native clime is wonderful, and inexplicable under any other principle than that of Divine superintendence. But upon this I shall have occasion to enlarge hereafter.

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[1] *Introd. to Ent.* ii. 433.

From what is here stated, it seems most probable, that it is not only the increasing heat of the southern regions which induces the *swallow* to seek a less ardent clime to transact her loves and rear her young; but also a stimulus, caused by the heat, acting upon her organization, which aids to accomplish that important purpose, and is the leading star by which her Creator impels her to the land of her own nativity, and which is destined to be that of her offspring. Only the swift leaves a colder climate for one more genial and better suited to the same purpose, and both return from whence they came, when the errand of their voyage is fully accomplished. One sent away by too great heat, and the other by a gradual decreement of the amount of heat, and also of their customary food.

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[1] *Hirundo rustica.*

Vieillot says, that all the swallows do not quit the warm countries to which they betake themselves in winter—that one part migrates, while another remains stationary, during the whole year, in Egypt, Ethiopia, and other tropical countries and islands.

But, besides the insectivorous emigrators, many of the higher and more powerful tribes are accustomed to change one country for another. When the carcasses of animals putrify, and birds multiply under the influence of the northern sun, vultures, eagles, falcons, hawks, &c. leave the south and go to partake of the feasts provided for them in higher latitudes.

But, besides the birds that visit us during the more genial part of the year, and add so greatly to the beauty and music of our groves in spring and summer, there are others, and those a numerous tribe, that wing hither their way when the reign of winter has commenced. The most numerous of these are the birds which the Author of nature has fitted to disport themselves and seek their food in the water, or which frequent humid and watery places. When the Arctic seas, and lakes, and rivers, present an unbroken field of impenetrable ice, the various web-footed birds, the swans[1] and geese,[2] and ducks[3] and divers,[4] and coots,[5] and an infinity of others, forming their angular and sometimes triangular phalanxes, each in turn taking the lead and first cutting the air,[6] fly off, often at a great height, to seek in more southern climates, not a region devoid of the usual concomitants of winter, frost and snow, but where their rigours are mitigated, so as to afford to these creatures the means of life. Now, also the waders, usually distinguished by their long legs and long beaks, as the woodcock,[7] the curlew, and the snipes,[8] leave their native marshes and haunts to seek others whose unfrozen or partially frozen morasses afford them a supply of the worms and vermicles or similar animals that form their usual nutriment. Many a time, when a boy, have I pursued the field-fare,[9] which is one of our winter guests, from tree to tree, without its affording me an opportunity of taking aim at it, as if it was aware of my purpose, and could smell the contents of my musket; no sooner did I get within a couple of hundred yards, than, with all its company, it flew a little further, and thus kept tantalizing me for hours, without my even being able to secure one. These birds, if the weather becomes very severe here, are said to fly further south in search of food, and to return again.

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[1] *Cycnus.* [2] *Anser.* [3] *Anas.*

[4] *Mergus* and *Colymbus.* [5] *Fulica.*

[6] N. Dict. D'Hist. Nat. xx. 544.

[7] *Rusticola vulgaris* Vieill. *Numenius arquatus.*—Lath.

[8] *Scolopax Gallinago and Gallinula.* [9] *Turdus pilaris.*

Thus, we see the change of seasons brings with it a change in the winged inhabitants of every country; and the winter immigration of a vast variety of birds, fit for food and other useful purposes, makes up in some degree for the summer or autumnal emigration of those, which being constantly before our eyes moving in every direction, and rendering vocal every grove or tree and even the very heavens, entertain our senses of seeing and hearing in a most delightful manner. Thus, also, all countries partake in some degree, by this shifting scene of animal life, of the same blessings and pleasures derived from the same instruments.

Though the production and rearing of their young forms a principal feature in most of the migrations before noticed, yet it is most prominent and conspicuous in the animals, whose annual motions I shall next advert to. And here mankind is more conspicuously indebted to the fatherly care and bounty of a beneficent Providence for a supply of their wants, than in any of the cases above detailed; which most of them minister to our pleasures, rather than our sustenance. *When the time of the singing birds is* *come, and the voice of the* nightingale *is heard in our land;* when the swallow and the swift delight us by their rapid and varied motions, now skimming the surface of the waters, now darting, either aloft or with more humble flight over the earth; when the carolling lark ascends towards heaven, teaching us to look up and learn from her where to direct the best affections of our hearts; these all excite in us delightful sensations, and merit our grateful acknowledgment, but still they contribute little or nothing to the means of life. The locusts indeed, who headed the list of emigrators, at the same time that they lay waste a country, supply its inhabitants with food, and thus make some recompense for their ravages; and a considerable proportion of the winter birds mentioned under the last head, as the swimmers[1] and the waders,[2] furnish our tables with dainty meats; but they come not in such numbers as to add materially to the general stock of food, or to contribute to the maintenance of the poor, as well as to the enjoyments of the rich. The animals I allude to under the present head, form the sole food of some nations, and contribute a vast and cheap supply, that covers the table of the poor man with plenty. The migrating *fishes* are one of the greatest and most invaluable gifts of the Creator to his creature man, by which thousands

[1] *Natatores.*

[2] *Grallatores.*

and thousands support themselves, and their families; and which, at certain periods, form the food of millions. Of the proceedings of the principal of these fishes, I shall now give a brief account.

I begin with one of the *cartilaginous* fishes—the *Sturgeon.* There are two noted species of this fish, which is related to the shark, the one is called the sturgeon[1] by way of eminence, and the other the huso.[2] The latter is found only in the Caspian and Black seas, and the Don, the Volga, and other rivers that flow into them. It is stated to be much larger than the sturgeon: Pallas describes one that weighed 2800 pounds, which it is conjectured must have been nearly forty feet long. Its ordinary length is stated to be twenty-five feet, which is the maximum of the sturgeon. The numbers of this species far exceed those of the latter, the caviar is usually made of its spawn, which equals nearly a third of the weight of the whole fish, from whence we may conjecture the infinite number of eggs that it contains. Professor Pallas gives a very interesting history of the manner in which these enormous fish are taken in the Volga, and the Saiek, which discharge their waters into the Caspian. And it seems really wonderful that so wild and illiterate a people as the Tartars, who have no acquaintance with the arts and sciences, should on this occasion, shew as much genius and invention as the most enlightened nations. The huso enters the rivers to spawn earlier than the sturgeon, generally about midwinter, when they are still covered with ice. At this time the natives construct dikes across the rivers in certain parts, formed with piles, leaving no interval that the huso can pass through; in the centre of the dike is an angle opening to the current, which consequently is an entering angle to the fish ascending the stream; at the summit of this angle is an opening, which leads into a kind of chamber formed with cord, or osier hurdles, according to the season of the year. Above the opening is a kind of scaffold, and a little cabin, where the fishermen can retire and warm themselves or repose, when they are not wanted abroad. No sooner is the huso entered into the chamber, which is known by the motion of the water, than the fishermen on the scaffold let fall a door, which prevents its return to seaward, they then by means of ropes and pullies lift the movable bottom of the chamber, and easily secure the fish.

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[1] *Accipenser Sturio.*

[2] *A. Huso.*

Gmelin has related, in a very lively way, the solemn fishing which takes place at the beginning of winter, in the neighbourhood of Astracan, when these fish have retired into vast caves under the seashore, which form their winter quarters. A great number of fishermen assemble, over whom are placed a director and inspectors, who possess considerable authority and influence; every kind of fishing is prohibited, in the places known to be the haunt of the husos; a numerous flotilla of boats are in readiness; every thing is prepared as it were for an important military operation; all approach in concert and with regular manœuvres the asylum in which the fish are concealed, the slightest noise is severely interdicted, so that the most profound silence every where prevails. In an instant, at a given signal, a universal shout rends the heavens, which echo multiplies on every side. The astonished husos, in the greatest alarm, rush from their hiding places, and are taken in nets of every kind, prepared to intercept them.

The huso fishery is of great importance, principally on account of the caviar prepared from the roe of these fishes, and the isinglass that is made from their air-vessel. The former is much in demand amongst many nations, as the Russians, Turks, &c.; the Greeks particularly make it almost their sole food during their long fasts, and the latter is almost universally an article of commerce. The common sturgeon furnishes the same articles, as do other fishes also.

The next kind of fishes that migrate for the purpose of spawning, which I shall notice, is one, which though it falls far behind the sturgeons in size, exceeds them infinitely in numbers and dispersion, and in the vast supply of food with which it furnishes the human race; it will readily be seen that I am speaking of the *Cod-fish.*[1] This valuable animal belongs to the class of fishes with a bony skeleton, and the tribe of *Jugulars*, or those whose ventral fins are nearer the mouth than the pectoral. It frequents shallows and sandbanks, between the fortieth and sixtieth degrees of North Latitude, both in the Atlantic and Pacific Oceans, where it is taken in infinite numbers. The fishery for it employs both European and American seamen and vessels in abundance. The most celebrated is that on the great bank of Newfoundland, where thousands of men are employed in catching, salting, and barrelling these fish, and whence they are dispersed principally into the Catholic countries, where they form a considerable portion of the food of the people, especially during lent and other fasts.

The cod-fish makes for the coast at spawning time, going northward, this takes place towards the end of winter, or the beginning of spring. Leeuwenhoek counted more than nine millions of eggs in a cod-fish of the middle size; allowing for a large consumption by other fishes which devour them, still enough are left, that when hatched produce a superabundant supply. They are deposited in the inequalities of the bottom amongst the stones.

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[1] *Gadus Morhua.*

The *Haddock*[1] is another species belonging to this genus, which frequents our coast in great numbers in mid-winter; they are stated sometimes to form a bank twenty-four miles long by three broad. They pursue and devour the herrings, and are themselves in their turn devoured by Sharks, which follow their shoals.

The next tribe of migratory fishes is one which supplies our tables with a very acceptable successor, when the cod-fish is out of season, and which at last usually becomes so plentiful and cheap as to form a part of the poor man's bill of fare, as well as of that of his rich neighbour. Every one will see that I here allude to the *Mackarel*.[2] This is one of the *thoracic* fishes, or those whose ventral fins are situated below the pectoral. It is very widely dispersed, being found in the Arctic, Antarctic, and Mediterranean Seas, as well as in the Atlantic Ocean. It hybernates in the seas first mentioned, where it is stated to select certain depths of the sea called by the natives Barachouas, which are so land-locked, that the water is as calm at all times, as in the most sheltered pools; the depth of these asylums diminishes in proportion to the proximity of the shore, and the bottom is generally muddy and covered with marine plants. It is in these muddy bottoms that the mackarel, directed by their instinct, pass the winter. They plunge their head and the anterior part of their body in the mud, keeping their tails elevated vertically above it. In the spring they emerge, in infinite shoals from their hiding places, and proceed southward for the purposes of depositing their eggs in more genial seas; more than half a million of these have been discovered in a single female.[1] These fish die as soon as they are taken out of the water, and then they emit a phosphoric light. The *Scomber* is one of the fishes, which, according to Pliny, was used for making the celebrated Roman pickle named *Garum*, and he calls it a fish good for nothing else: if he means our mackarel, it is singular that its value, as an article of food, should not have been discovered. The *Garus* or *Garum* derived its name from a crustaceous animal so called, from which it was sometimes made. Apicius is said by Pliny to have employed the liver of the mullet in concocting it.

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[1] *Gadus Œgelfinus.*

[2] *Scomber Scombrus.*

What the mackarel is to the north of Europe, the *Thunny* is to the south. It deposits its eggs in May and June, when it enters the Mediterranean, seeking the shores in shoals arranged in the form of a parallelogram, or as some say, a triangle, and making a great noise and stir. They appear to have been much in request with the Greeks and Romans, and are now an important article of food with the inhabitants of the coasts and islands of the Mediterranean.

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[1] *Scomber Thynnus.*

But no fish is so important a gift of Heaven, as affording employment to a large number of individuals both in the catching and preparing it, and as adding very largely to the general stock of food, especially in Catholic countries, as that of whose history I shall next give a brief sketch.

Three thousand decked vessels, of different sizes, besides smaller boats, are stated to be annually employed in the herring-fishery, with a proportionable number of seamen, besides a vast number of hands that, at certain seasons, are occupied in curing them.

The *herring* to which I now allude belongs to the tribe called *abdominal* fishes, or those whose ventral fins are behind the pectoral, and may be said to inhabit the arctic seas of Europe, Asia, and America, from whence they annually migrate, at different times, in search of food and to deposit their spawn. Their shoals consist of millions of myriads, and are many leagues in width, many fathoms in thickness, and so dense that the fishes touch each other; they are preceded, at the interval of some days, by insulated males. The largest and strongest are said to lead the shoals, which seem to move in a certain order, and to divide into bands as they proceed, visiting the shores of various islands and countries, and enriching their inhabitants. Their presence and progress are usually indicated by various sea-birds, sharks, and other enemies. One of the cartilaginous fishes, the sea-ape,[1] is said to accompany them constantly, and is thence called the king of the herrings. They throw off also a kind of oily or slimy substance, which extends over their columns, and is easily seen in calm weather. This substance, in gloomy still nights, exhibits a phosphoric light, as if a cloth, a little luminous, was spread over the sea.

Some conjecture may be formed of the infinite numbers of these invaluable fishes that are taken by European nations from what Lacepede relates —that in Norway twenty millions have been taken at a single fishing, that there are few years that they do not capture four hundred millions, and that at Gottenburgh and its vicinity seven hundred millions are annually taken; "but what are these millions," he remarks, "to the incredible numbers that go to the share of the English, Dutch, and other European nations."

Migrations of these fishes are stated to take place at three different times. The first when the ice begins to melt, which continues to the end of June; then succeeds that of the summer, followed by the autumnal one, which lasts till the middle of September. They seek places for spawning, where stones and marine plants abound, against which they rub themselves alternately on each side, all the while moving their fins with great rapidity. According to Lacepede, William Deukelzoon, a fisherman of Biervliet, in Dutch Flanders, was the first person who salted herrings, this was before the end of the fourteenth century; others attribute this invention to William Benckels or Benkelings of Bierulin. To shew his sense of the importance of this invention, the Emperor Charles V. is stated to have visited his tomb, and to have eaten a herring upon his grave. The smoking of this valuable fish, we are told, was first practised by the inhabitants of Dieppe in Normandy.

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[1] *Chimæra monstrosa.*

Next to the herring, the pilchard[1] is valuable to our own country, especially to the inhabitants of Cornwall and Devonshire, to whom this fish is as important as the herring to other parts of the kingdom; they frequent the southern coasts from the middle of summer to the end of autumn, and many thousand barrels are annually cured. Lacepede says that, in one year, a milliard[2] of these fishes has been taken.

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[1] *Clupanodon Pilcardus.*

[2] One thousand million.

The sprat[1] and the anchovy,[2] are two other fishes of the present tribe, the former, at certain seasons, furnishing a considerable supply of food to the lower orders, and also a fertilizing kind of manure to the farmer and hop-grower, though, it must be confessed, very annoying to the traveller passing through a country where it is so employed, by its disagreeable stench, and to those who inhabit it by its putrid effluvia, which I have known to produce fevers; the other ministering to the enjoyment and luxury of the wealthy by its piquancy when pickled, or reduced to an essence; but on these I shall not further enlarge.

The next tribe of migratory fishes is one whose several species are intermediate between marine and fresh-water fishes, roving indifferently in the sea, and rivers, and lakes, and thus is fitted by Providence to make up to the inhabitants of inland countries their distance from the other migrators, by a supply brought, as it were, to their very doors. The fishes in question belong also to the abdominal class, and form the salmon genus, including the salmon,[3] the salmon-trout,[4] the trout,[5] the grayling,[6] the charr,[7] the smelt,[8] the hucho,[9] and many other species. I shall, however, confine my observations principally to

[1] *Clupea Sprattus.*
[2] *C. encrasicolus.*
[3] *Salmo Salar.*
[4] *S. Trutta.*
[5] *S. Fario.*
[6] *S. Thymallus.*
[7] *S. Alpinus.*
[8] *S. Eperlanus.*
[9] *S. Hucho.*

the king, as it may be called, of the river migrators,—the *Salmon*. In our own country this noble fish is too high-priced to form a general article of food, and may be reckoned amongst the luxuries of the rich man's table; but in others, especially amongst some of the North-western American tribes, they are gifts of Providence, which form their principal food at all seasons. One, which Sir George Mackenzie fell in with, in his journey from Canada to the Pacific, were perfect Ichthyophagites, and would touch no other animal food. These people construct, with great labour and ingenuity, across their streams, salmon weirs, which are formed with timber and gravel, and elevated nearly four feet above the level of the water; beneath machines are placed, into which the salmon fall when they attempt to leap over the weir. On either side is a large frame of timber-work, six feet above the level of the upper water, in which passages are left for the salmon, leading into the machines. When they catch their salmon they string them and suspend them, at first, in the river. The women are employed in preparing and curing these fish; for this purpose they appear to roast them first, and then suspend them on the poles that run along the beams of their houses, in which there are usually from three to five hearths, the heat and smoke from which contribute, no doubt, to their proper curing.

The salmon, indeed, frequents every sea, the arctic as well as the equatorial; it is found even in great lakes and inland seas, as the Caspian, into which it is even affirmed to make its way by a subterranean channel from the Persian Gulf—it goes as far south as New Holland and the Australian seas; but, it is said never to have been found in the Mediterranean, and appears to have been unknown to Aristotle. Pliny mentions it as a river fish, preferred to all marine ones by the inhabitants of Gaul. It traverses the whole length of the largest rivers. It reaches Bohemia by the Elbe, Switzerland by the Rhine, and the Cordilleras of America by the mighty Maragnon, or River of Amazons, whose course is more than three thousand miles. In temperate climates the salmon quits the sea early in the spring, when the waves are driven by a strong wind against the river currents. It enters the rivers of France in the beginning of the autumn, in September; and in Kamtchatka and North America still later. In some countries this is called the salmon-wind. They rush into rivers that are freest from ice, or where they are carried by the highest tide, favored by the wind; they prefer those streams that are most shaded. They leave the sea in numerous bands, formed with great regularity. The largest individual, which is usually a female, takes the lead, and is followed by others of the same sex, two and two, each pair being at the distance of, from three to six feet from the preceding one; next come the old, and after them the young males in the same order.

The noise they make in their transit, heard from a distance, sounds like a far off storm. In the heat of the sun and in tempests, they keep near the bottom; at other times they swim a little below the surface. In fair weather they move slowly, sporting as they go at the surface, and wandering again and again from their direct route; but when alarmed they dart forward with such rapidity that the eye can scarcely follow them. They employ only three months in ascending to the sources of the Maragnon, the current of which is remarkably rapid, which is at the rate of nearly forty miles a day; in a smooth stream or lake, their progress would increase in a fourfold ratio. Their tail is a very powerful organ, and its muscles have wonderful energy; by placing it in their mouth they make of it a very elastic spring, for letting it go with violence they raise themselves in the air to the height of, from twelve to fifteen feet, and so clear the cataract that impedes their course; if they fail in their first attempt, they continue their efforts till they have accomplished it. The female is stated to hollow out a long and deep excavation in the gravelly bed of the river to receive her spawn, and when deposited to cover it up, but this admits of some doubt.

Amongst the migrations of fishes, I must not neglect those that take place in consequence of the water in the ponds or pools that they inhabit being dried up: some of these are very extraordinary, and prove that when the Creator gave being to these animals, he foresaw the circumstances in which they would be placed, and mercifully provided them with means of escape from dangers to which they were necessarily exposed.

In very dry summers, the fishes that inhabit the above situations, are reduced often to the last extremities, and endeavour to relieve themselves by plunging, first their heads, and afterwards their whole bodies, in the mud to a considerable depth; and so, though many in such seasons perish, some are preserved till a rainy one again supplies them with the element so indispensable to their life. Carp, it is known, may be kept and fed a very long time in nets in a damp cellar, a faculty which fits them for retaining their vitality when they bury themselves at such a depth as to shelter them from the heat.

But others, when reduced to this extremity, desert their native pool, and travel in search of another that is better supplied with water. This has long been known of eels, which wind, by night, through the grass in search of water, when so circumstanced. Dr. Hancock, in the Zoological Journal, gives an account of a species of fish, called, by the Indians, the Flat-head Hassar, and belonging to a genus[1] of the family of the Siluridans, which is instructed by its Creator, when the pools, in which they commonly reside, in very dry seasons, lose their water, to take the resolution of marching by land in search of others in which the water is not evaporated. These fish grow to about the length of a foot, and travel in large droves with this view; they move by night, and their motion is said to be like that of the two-footed lizard.[2] A strong serrated arm constitutes the first ray of its pectoral fin.[3] Using this as a kind of foot, it should seem, they push themselves forwards, by means of their elastic tail, moving nearly as fast as a man will leisurely walk. The strong plates which envelope their body, probably, facilitate their progress, in the same manner as those under the body of serpents, which in some degree perform the office of feet. It is affirmed by the Indians, that they are furnished with an internal supply of water sufficient for their journey, which seems confirmed by the circumstance that their bodies when taken out of the water, even if wiped dry with a cloth, become instantly moist again. Mr. Campbell, a friend of Dr. Hancock's, resident in Essequibo, once fell in with a drove of these animals, which were so numerous, that the Indians filled several baskets with them.

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[1] *Doras.*

[2] *Bipes.*

[3] PLATE XII. FIG. 1. is a species of *Callicthys*, a fish of the same habits with the *Doras*. FIG. 2. is the pectoral ray of another Siluridan, which was dug up in a village near Barham, but which is not a fossil bone.

Another migrating fish was found by thousands in the ponds and all the fresh waters of Carolina, by Bosc; and as these pools are subject to be dry in summer, the Creator has furnished this fish, as well as one of the flying ones,[1] by means of a membrane which closes its mouth, with the faculty of living out of water, and of travelling by leaps, to discover other pools. Bosc often amused himself with their motions when he had placed them on the ground, and he found that they always direct themselves towards the nearest water, which they could not possibly see, and which they must have discovered by some internal index; during their migrations they furnish food to numerous birds and reptiles. They belong to a genus of abdominal fishes,[2] and are called swampines. It is evident from this statement that these fishes are both fitted by their Creator, not only to exist, but also move along out of the water, and are directed by the instinct implanted by him, to seek the nearest pool that contains that element; thus furnishing a strong proof of what are called compensating contrivances; neither of these fishes have legs, yet the one can walk and the other leap without them, by other means with which the Supreme Intelligence has endowed it. I may here observe that the serrated bone, or first ray of the pectoral fin, by the assistance of which the flathead appears to move, is found in other Siluridans, which leads to a conjecture that these may sometimes also move upon land.

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[1] *Exocœtus.*

[2] *Hydrargyra.*

Another fish,[1] found by Daldorff, in Tranquebar, not only creeps upon the shore, but even climbs the Fan palm[2] in pursuit of certain Crustaceans which form its food. The structure of this fish peculiarly fits it for the exercise of this remarkable instinct. Its body is lubricated with slime which facilitates its progress over the bark, and amongst its chinks; its gill-covers are armed with numerous spines, by which, used as hands, it appears to suspend itself; turning its tail to the left, and standing, as it were, on the little spines of its anal fin, it endeavours to push itself upwards by the expansion of its body, closing at the same time its gill-covers, that they may not prevent its progress; then expanding them again it reaches a higher point; thus, and by bending the spiny rays of its dorsal fins to right and left, and fixing them in the bark, it continues its journey upwards. The dorsal and anal fins can be folded up and received into a cavity of the body.

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[1] *Perca scandens.*

[2] *Borassus flabelliformis.*

How exactly does this structure fit it for this extraordinary instinct. These fins assist it in certain parts of its route, and, when not employed, can be packed up so as not to hinder its progress. The lobes of its gill-covers are so divided and armed as to be employed together, or separately, as hands, for the suspension of the animal, till, by fixing its dorsal and anal fins, it prepares itself to take another step; all showing the Supreme Intelligence and Almighty hand that planned and fabricated its structure, causing so many organs, each in its own way, to assist in promoting a common purpose. The fan palm, in which this animal was taken by Daldorff, grew near the pool inhabited by these fishes. He makes no mention, however, of their object in these terrestrial excursions; but Dr. Virey observes that it is for the sake of small Crustaceans, on which they feed.

I shall name only one more animal that migrates for the great purpose of reproduction, and this is not the least interesting of them; and, though it does not furnish so large a supply of food to the countries it passes through, as the migratory fishes, still it is useful in that respect: the animal I allude to is the *land-crab*.

Several, indeed, of the crabs forsake the waters for a time, and return to them to cast their spawn; but the most celebrated of all is that known by the above appellation, and alluded to by Dr. Paley, under the name of the violet crab, and which is called by French the tourlourou.[1] These crabs are natives of the West Indies and South America. In May and June, when the rainy season takes place, their instinct impels them to seek the sea, that they may fulfil the great law of their Creator, and cast their spawn.

They descend the mountains, which are their usual abode, in such numbers, that the roads and woods are covered with them. They feel an impulse so to steer their course, that they may travel by the easiest descent, and arrive most readily at the sea, the great object at which they aim. They resemble a vast army marching in battle array, without breaking their ranks, following always a right line; they scale the houses, and surmount every other obstacle that lies in their way. They sometimes even get into the houses, making a noise like that of rats, and when they enter the gardens they commit great devastations, destroying all their produce with their claws. They are said to halt twice every day, and to travel chiefly in the night. Arrived at the sea-shore, they are there reported to bathe three or four different times; when retiring to the neighbouring plains, or woods, they repose for some time, and then the females return to the water, and commit their eggs to the waves. This business dispatched, they endeavour to regain, in the same order, the country they had left, and by the same route, but only the most vigorous can reach the mountains. The greater part are so weak and lean, that they are forced to stop to recruit their strength in the first country they reach. When arrived again at their habitations, they have a new labour to undergo, for now is the time of their moult. They hide themselves in their subterranean retreats for this purpose, so that not a single one can be seen: they even stop up the mouth of their burrows. Some writers, however, affirm that they change their shells immediately after their oviposition.

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[1] *Gecarcinus carnifex.*

The respiration of these land-crabs, for a long time, had puzzled comparative anatomists.—They could not explain how animals, breathing by gills, could subsist so long out of the water without these organs becoming useless. M. M. Audouin, however, and Milne Edwards, cleared up the mystery by the discovery of a kind of trough, formed by the folds which line and constitute the parietes of the branchial cavity, and destined to contain and preserve a certain quantity of water proper to moisten the gills. One species[1] has more than one pocket, or vesicle, filled with that fluid. This trough exists in the horsemen land-crabs,[1] but it is smaller, and a spongy mass furnishes the requisite moisture. The gills of the land-crabs, in other respects, do not differ from those of the tribe in general. God, when he formed these animals, would not separate them from their kind by a different mode of respiration, but by this compensating contrivance he fitted them for the circumstances in which he decreed to place them, and for a long sojourn out of the water.

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[1] *Gecarcinus Uca.*

What is the great object of this law of the Creator, that impels them to seek, in many cases, a mountain retreat, at a distance from the ocean, which forms the liquid atmosphere fitted to the great body of the Crustaceans, has not hitherto, for want of sufficient and accurate details of their history, been made fully obvious. When insects leave the waters to become denizens of the earth and air, the object appears evidently an increase of food, not only for terrestrial animals, whether moving on the one or in the other, but to multiply even that of the inhabitants of the waters. When the day-flies[2] burst in such myriads from the banks of rivers which they inhabited in their first state, the fishes are all in motion, and often jump from the water to catch the living flakes that are every moment descending. When in the

[1] *Ocypode.*

[2] *Ephemera.*

water, or under it, these animals and the may-flies are defended, or concealed from the fishes, and therefore are not so easy to come at; but now is their harvest, and when they drop their eggs, they fall towards the stream, and it is deemed a shower of manna.

The same object brings the several kinds of land-crabs at stated times to sea, to deposit their eggs where their young may reach a certain maturity, if not undergo a metamorphosis; probably at this period there is an assemblage of aquatic devourers of Crustaceans, to share in the expected harvest. And during the route of the myriads that thus migrate to the sea, beasts and birds, and man himself, all partake of the feast thus provided for them.

If we give this subject of the migration of animals due consideration, and reflect what would be the consequence if no animals ever changed their quarters, we shall find abundant reason for thankfulness to the Almighty Father of the universe, for the care he has taken of his whole family, and of his creature man in particular, consulting not only his sustentation and the gratification of his palate by multiplying and varying his food, but also that of his other senses, by the beauty, motions, and music of the animals that are his summer or winter visiters: did the nightingale forsake our groves, the swallow our houses and gardens, the cod-fish, mackarel, salmon, and herring our seas, and all the other animals that occasionally visit us their several haunts, how vast would be the abstraction from the pleasure and comfort of our lives.

By means of these migrations, the profits and enjoyments derivable from the animal creation are also more equally divided, at one season visiting the south, and enlivening their winter, and at another adding to the vernal and summer delights of the inhabitant of the less genial regions of the north, and making up to him for the privations of winter. Had the Creator so willed, all these animals might have been organized so as not to require a warmer or a colder climate for the breeding or rearing of their young: but his will was, that some of his best gifts should thus oscillate, as it were, between two points, that the benefit they conferred might be more widely distributed, and not become the sole property of the inhabitants of one climate: thus the swallow gladdens the sight both of the Briton and the African; and the herring visits the coasts, and the salmon the rivers of every region of the globe. What can more strongly mark design, and the intention of an all-powerful, all-wise, and beneficent Being, than that such a variety of animals should be so organized and circumstanced as to be directed annually, by some pressing want, to seek distant climates, and, after a certain period, to return again to their former quarters; and that this instinct should be productive of so much good to mankind, and, at the same time, be necessary, under its present circumstances, for the preservation or propagation of the species of these several animals.

There is another view that may be taken of this subject, equally shewing the attention of the Almighty Father to the wants of every description of his creatures. The migrating tribes of almost every kind are attended by numerous bands of predaceous animals, which, as well as man, partake in the general harvest; the bears, wolves, foxes, dogs, and, in tropical countries, other beasts of prey, hang on the flanks of the bands of emigrators, and capture and devour the stragglers. The vultures, and other carnivorous birds, follow and share in the spoil: and the emigrating fishes are attended by whole tribes of predaceous birds and fishes, which thin their numbers before they are taken by the nets of the fisherman.

I am next to say something on the local distribution of animals. By their *local* distribution, I mean their station in any given country. Under this head they may be divided into terrestrial, amphibious, and aquatic.

The local distribution of *terrestrial* animals is very diversified. Some inhabit the loftiest mountains, here the eagle builds its aërie, and the condor[1] deposits its eggs on the bare rock; and here the chamois[2] often laughs at the efforts of the hunter, astonishing him by the ease with which it scours over the rocks, or with which it ascends or descends the most inaccessible precipices.

Some animals, that in high latitudes are found in the plains, in a warmer atmosphere seek the mountains. Of this description is the beautiful Apollo butterfly,[3] which, in Sweden is very common in the country and gardens about Upsal, while in France it is found only on mountains between three and four thousand feet above the level of the sea. I received very fine specimens collected by a friend in the Pyrenees. The common viper[4] also, which in northern Europe is found in the plains, in southern is found only on Alpine or Subalpine mountains.

It has been observed by an ingenious and learned writer, that the terrestrial globe seems to be formed of two immense mountains, set base to base at the equator, and that upon each of these hemispheres the vegetables and animals are generally placed in parallel zones, according to the degree of heat or cold. The exceptions to this rule, he further observes, are easy to be appreciated, and confirm its truth, since the mountains, the various elevations and depressions of the country, which even under the same parallel modify the ordinary temperature, produce vegetables, and often animals, analogous to their several degrees of heat or cold. The lofty mountains in tropical countries, exhibit from their base to their snow-clad summits, the same gradation as these hemispheres present in going from the equator towards the poles.

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[1] *Sarcorhamphus Gryphus.*

[2] *Antilope Rupicapra.*

[3] *Parnassius Apollo.*

[4] *Coluber berus.*

The majority, however, of animals do not ascend such heights, but seek their subsistence in the plains, and less elevated regions; yet here a considerable difference obtains according to the nature of the soil and country. The vast sandy desarts of Africa and Asia, the Steppes of Tartary, the Llanos and Pampas of South America have their peculiar population; in the former the camel, and his master the Arab, whose great wealth he constitutes, are indigenous; in the latter the horse and the Tartar who rides and eats him; or the Hispano-American, and the herds of horses and oxen, returned to their wild and primitive type, who snares them with his lasso, and reduces them again to the yoke of man. Numerous also are the peculiar animal productions to which different soils afford subsistence. The sea-shore, sandy and barren wastes, woods and forests, arable lands, pasture, meadow and marsh, all are thus distinguished; every plant almost is inhabited by insects appropriated to it, every bird has its peculiar parasite or louse;[1] and not only are the living animals so infested, but their carcasses are bequeathed to a numerous and varied army of dissecters, who soon reduce them to a naked skeleton; nay, their very excrements become the habitation of the grubs of sundry kinds of beetles and flies.

But not only is the surface of the earth and its vegetable clothing, thickly peopled with animals, but many, even quadrupeds and reptiles, as well as insects and worms, are subterranean, and seek for concealment in dens, caves and caverns, or make for themselves burrows and tortuous paths at various depths under the soil, or seek for safety and shelter, by lurking under stones or clods, and all the dark places of the earth.

To other animals, in order to pass gradually from such as are purely terrestrial, to those that are aquatic, Providence has given the privilege to frequent both the *earth* and the *water*; some of which may be regarded as belonging to the former, and frequenting the latter, as water fowl of various kinds, the amphibious rat,[2] the architect beaver,[3] many reptiles, and some insects; others again as belonging to the latter, and frequenting the former; for instance, the sea-otter,[1] and the different kinds of seal[2] and morse,[3] the turtle,[4] the penguin,[5] several insects,[6] and the water-newts.[7] Other amphibious animals, if they may be so called, are aquatic at one period of their life, and terrestrial at another; this is particularly exemplified in some insects, thus the grubs of water-beetles,[8] those of dragon-flies,[9] may-flies,[10] ephemeral-flies,[11] water-moths,[12] gnats or mosquitos,[13] and several other two-winged flies, live in the water, while the perfect insect is either amphibious as the beetle, or terrestrial as the remainder.

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[1] *Nirmus.* [2] *Lemmus amphibius.* [3] *Castor Fiber.*

But no part of this terraqueous globe is more fully peopled, and with a greater variety and diversity of beautiful, or strange, or monstrous forms, than the waters, from the infinite ocean to the most insignificant pool or puddle. Every part and portion of the supposed element of water; nay, almost every drop of that fluid teems with life. Thousands of aquatic species are known, but myriads of myriads never have been seen and never will be seen by the eye of man.

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[1] *Enhydra marina.*

[2] *Phoca.*

[3] *Trichechus.*

[4] *Chelonia Mydas.*

[5] *Aptenodytes.*

[6] *Dyticus, Gyrinus, Ranatra, &c.*

[7] *Salamandræ aquaticæ.*

[8] *Dyticidæ, Hydrophilidæ, Gyrinidæ.*

[9] *Libellulina.*

[10] *Trichoptera.*

[11] *Ephemeridæ.*

[12] *Hydrocampa.*

[13] *Culex.*

Amongst those that inhabit fluids, none are more wonderful than those that are termed Infusories;[1] because they are usually found in infusions of various substances, &c.; when dry, these animals lose all signs of life, but upon immersion, even after the lapse of years, they immediately awake from their torpor and begin to move briskly about. Even the air, according to Spallanzani, seems to contain the germes or eggs of these infinitesimals of creation, so that we swallow them when we breathe, as well as when we drink.

With respect to animals more entirely *aquatic*, some inhabit, as the majority of sea-fishes and animals, salt waters only, some salt at one time and fresh at another, as the species of the salmon genus, the sturgeon, &c.; and some frequent brackish waters, as some flat-fish, and shell-fish.

The bed of the mighty ocean is not only planted with a variety of herbs, which afford pasture to many of its animal inhabitants, but it has other productions which represent a forest of trees and shrubs, and are, strictly speaking, the first members of the zoological world, connecting it with the vegetable; these are denominated Zoophytes or animal plants, and Polypes (*Polypus*). This last name has been adopted from Aristotle; with him however and the ancients, it is evidently used to designate the Argonaut[1] and Nautilus of the moderns, and also to include some terrestrial shells. The Zoophytes however are not confined to the ocean, every rivulet, and stagnant ditch or pool affords to some kinds, more commonly denominated Polypes, and also to some sponges, their destined habitation. An infinite army of shell-fish, whether multivalve, bivalve, or univalve, also cover the bed of the ocean, or move in its waters, and some dance gaily on its surface with expanded sails, or dashing oars when tempted by fair weather.

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[1] *Infusoria, Acrita, Agastria, Amorpha, Microscopica.*

From this brief view of the local distribution of animals and their various haunts, we see the care of Divine Providence, that no place, however, at first sight, apparently unfit, might be without its animal as well as vegetable population: if the hard rock is clothed with a lichen, the lichen has its inhabitant: and that inhabitant, besides affording an appropriate food to the bird that alights upon the rock, or some parasite that has been hatched in or upon its own body, assists in forming a soil upon it. There is no place so horrible and fetid from unclean and putrid substances, that is not cleansed and purified by some animals that are either its constant or nomadic inhabitants. Thus life, a life attended in most cases, if not all, with some enjoyment, swarms every where—in the air, in the earth, under the earth, in the waters—there is no place in which the will of an Almighty Creator is not executed by some being that hath animal life. What Power is manifested in the organization and structure of these infinite hosts of existences! what Wisdom in their adaptation to their several functions! and what Goodness and stupendous Love in that universal action upon all these different and often discordant creatures compelling them, while they are gratifying their own appetites or passions, and following the lead of their several instincts, to promote the good of the whole system, combining into harmony almost universal discord, and out of seeming death and destruction bringing forth life and health and universal joy! He who, as an ancient writer speaks, "Contains all things,"[1] can alone thus act upon all things, and direct them in all their ways to acknowledge him by the accomplishment of each wise and beneficent purpose of his will. Philo Judæus, in his book upon agriculture,[2] speaking of those words of the Psalmist, "*The Lord is my shepherd, therefore can I lack nothing*," has the following sublime idea, illustrative of this subject. "God, like a shepherd and king, leads, according to right and law, the earth, and the water, and the air, and the fire, and whatever plants or animals are therein, things mortal and things divine; the physical structure also of the heavens, and the circuit of the sun and moon; the revolutions and harmonious choirs of the other stars; placing over them his right Word the first born Son, who hath inherited the care of this Holy Flock, as the Viceroy of a mighty King."

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[1] *Argonauta.*

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[1] *Hermas.*

[2] Περι γεωργιας. 152. A. Ed. *Col. Allob.*

Chapter III.

Functions and Instincts of Animals.

Having, in the last chapter, stated how the dispersion and distribution of animals, under the Divine superintendence and direction, probably took place after the Deluge; and having likewise considered those temporary changes of place, either casual or periodical, which are still in operation, I shall next endeavour to give a general sketch of the animal kingdom, its classes and larger groups, and so much of their history, habits, and instincts, as may be necessary to indicate their several *functions* and *offices* in the general plan of creation, so as to illustrate more strikingly the Goodness that willed, the

WISDOM that planned, and the POWER that executed the wondrous whole; so that each in its place and station, by employing the faculties and organs, with which he has gifted it, in accomplishing his will, praises, though unconsciously, its Almighty and Beneficent Creator, thus loudly calling upon man, the rational head of the creation, to take up the strain and lead the general choir.

Before I descend to particulars, I must say a few words upon the general functions of the animal kingdom. These, like Janus, have a double aspect;—on one side they affect the vegetable world, and on the other their own body.

There is a singular contrast and contrariety between the majority of animals and vegetables. The head of the animal and the root or base of the vegetable perform the same office, that of collecting and absorbing the nutriment of each. The animal derives this nutriment from *organic* matter, the vegetable from *inorganic*. The plant gives oxygen to the heaven, and falling leaves and other matters to the earth. The animal gives nitrogen to the former, and the rejectamenta of its food to the latter. The most beautiful and admired, and odorous and elevated parts of the plant are its reproductive organs and their appendages, while in the animal they are the very reverse of this.

But, in all this, we see the wisdom and forethought of the Creator. We see how exactly, by this mutual inversion, each class of beings is fitted for its station and functions. The plant to take root in, invest and ornament the earth, and keep the atmosphere pure by a constant supply of vital air; the animal to browse and trim the vegetable, and by checking its luxuriance promote its welfare, to furnish it with a product calculated for its health and necessary to its existence; and by the manure, various in kind as the animals themselves, which it produces, supplying to the earth fresh pabulum for its vegetable tribes, and making good what it lost by the exhaustion, occasioned by the infinite myriads that, investing it on all sides like a garment, derive their nutriment from it, some plunging deep, and others, as it were, skimming the surface: if we contrast this with the returns they make, we shall be convinced that, in this case, the expenditure would vastly exceed the income, and that a class of beings was essentially necessary as a counterpoise, which, by taking little or nothing immediately from the soil, at the same time that they added to it, some in a greater and some in a less degree, might afford a sufficient supply of those principles which are indispensably requisite for the due nutriment and developement of the various members of the vegetable kingdom, and thus maintain an equilibrium, and make good the deficiency just stated.

There is another function which is devolved upon animals with respect to the vegetable kingdom; to keep the members of it within due limits, and to hinder them from encroaching too much upon each other. All organised beings have a natural tendency to increase and multiply; and while there is space this tendency is beneficial; but when plants or animals exceed certain limits, they stand in each other's way, and prevent all further growth or healthy progress. The herbivorous animals, in various ways, serve as a countercheck to this tendency, and keep the vegetable tribes from encroaching too much upon each other. As I have detailed the effects of this when I spoke of the ravages of the locusts, and shall have occasion again to notice it, I shall not now enlarge further upon it.

I am next to consider another general function of animals, or the effects they produce upon their own body: and here the reason just alluded to, their constant tendency to multiply so as to be injurious to each other, and also to vegetable productions, especially those that are important to man or beast, which in the present state of things is so constantly recurring, renders it necessary that some bounds should be set to their increase, which Providence effects by letting them loose against each other. The great object of the Creator is the maintenance of the whole system of creation in order and beauty, and this he is pleased to accomplish, not always by the *concord* but by the seeming *discord* of the agents he employs.

When we take a first view of nature we are struck by a scene which seems to be one of universal conflict, for the very heavens appear not clear from the charge: the philosopher who studies them tells us of antagonist powers, that are perpetually striving with each other, the one to absorb all things in a common centre, the other to dissever them, and scatter them in illimitable space, and when we turn to the earth, what a scene of destruction is before us! The king of the terrestrial globe, man, constantly engaged in a struggle with his fellow man, often laying waste the earth, slaughtering its inhabitants, and deforming its productions—his subjects of the animal kingdom following the example of their master, and pitilessly destroying each other—the strong oppressing the weak, and most seeming bent to annihilate the races to which they are opposed; so that, humanly speaking, in the lapse of ages, we might expect that one species of animals would be annihilated after another, till the whole were obliterated from the face of creation, and the sublime language of the prophet literally verified; "*I beheld the earth, and, lo, it was without form* *and void; and the heavens, and they had no light. I beheld the mountains, and, lo, they trembled, and all the hills moved lightly. I beheld, and, lo, there was no man, and all the birds of the air were fled.*"

But if, with our spirits depressed, by the prospect of so universal a scene of mutual struggles and destruction, we listen again to the philosopher, he will tell us that the ceaseless struggle of the antagonist powers of the heavens prevents, instead of causing disorder and confusion, that by the powerful and mutual counteraction of these mighty opponents, all the heavenly bodies of our system are prevented from rushing to the centre, or being driven, dispersed into their atoms, beyond the *flammantia mœnia mundi;* that thus their annual and diurnal revolutions are maintained, that each observes its appointed course, keeps its assigned station, and ministers to the good and well-being of the whole system. If then we turn our view again to the earth, and take a nearer survey of things—if we consider the present tendency to multiply, beyond measure, of all things that have life, we shall soon be convinced that, unless this tendency was met by some check, the world of animated beings would be perpetually encroaching upon each other, and would finally perish for want of sufficient food; and that the partial evils inflicted by one individual or one class upon another, to borrow a term from the Political Economist, proportions the demand to the supply; that thus both vegetables and animals are so accurately distributed, weighed so nicely against each other, as never to go a step beyond what God decrees, and what is most beneficial to the whole system; and that the actual number of every kind bears due relation to the work it has to do; and, upon closer inquiry, we find, that though since the creation, probably in consequence of the great change in the moral state of the world, superinducing physical changes also, some species no longer necessary may have perished, yet that, in general, they have maintained their ground from age to age, in spite of the attacks of the great army of destroyers. To maintain things in this state, thus to "*order all things in measure, number, and weight*," as the wise man speaks, to cause all so to harmonize, and so out of death and destruction to bring forth life, indicates still more strongly the constant and wise superintendence, and powerful arm of a watchful Providence, and demonstrates irrefragably that there is a Great Being constantly at work, either mediately or immediately, to produce effects that, without his constant superintendence and intervention, could never take place. And thus, as sings the bard of Twickenham,

> "All nature is but art unknown to thee,
> All chance direction which thou canst not see,
> All discord harmony not understood,
> All partial evil, universal good."

CHAPTER IV.

Functions and Instincts of the Infusory Animals.

As at the original creation of the animal kingdom, it was the will of the Supreme Being to begin at the *foot* of the scale and to terminate with man, who was at its *summit*, thus making a gradual progress towards the most perfect being it was his will to create, and ending with him: so I think it will best manifest his power and perfections if I endeavour to trace out the footsteps of the Deity in the same direction as he proceeded; and instead of beginning, as is usually done by systematical writers, with the *highest* grade of animals, if I ascend upwards from the *lowest*.

Our first inquiry must be what are these lowest animals? And are there any organized bodies that partake of *two* natures, that are either animal at one period of their existence and vegetable at another, or else are partly animal and partly vegetable? These doubtful forms must be sought for amongst what have been denominated *first-plants*[1] and *first-animals*;[2] amongst the former is a certain genus or tribe[3] of plants, which are distinguished not only by their simple structure, but also by an oscillatory movement which seems to connect them, in some degree, with the animal kingdom. When collected in masses they resemble a piece of green velvet. Some cover considerable spots in moist places; others live in the water, either fixed to substances contained in it, or floating on the surface. They are generally based on a mucilaginous substance, the remains of those that, having fulfilled their functions, are become a caput mortuum. The filaments of which the living plant is composed continually oscillate from right to left, or from left to right, but very irregularly, some going in one direction, others in another; some remaining stationary while others continue in motion.

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[1] *Protophyta.* [2] *Protozoa.* [3] *Oscillatoriæ.* Vauch.

Professor Agardh inclines to the opinion that these oscillating plants owe their existence to different species of *animalcules*, which at first swim about as animals, and afterwards fix themselves as plants. This opinion has been adopted by others; and lately Mr. Unger has stated that he has seen animated particles separate from the parent plant, in a few hours converted into globules of vegetable matter, which subsequently became plants perfectly similar to the individual from which they were produced.

But surely the motions of these seeds or germes, may be merely mechanical, and may be necessary to enable them properly to fix themselves, somewhat analogous to those mechanical contrivances by which the seeds of numerous plants, as those of the dandelion and cranesbill, are transported to a distance and enabled to enter the soil and fix themselves in it.

That any creature should begin life as an animal and end it as a plant seems to contradict the general analogy of creation, and requires much stronger proofs than appear to have been adduced in the present case, before it can be admitted. The motions of the oscillating plants are not very different from those of the stamina of some, and of the leaves of others, as the *Hedysarum gyrans;* yet Adanson has proved that the vibrations of the filaments are the same both in hot and cold weather, and that the aquatic species are equally sensible with the terrestrial, therefore the movement can scarcely be caused by the temperature. But as analogous motions were observed by Mr. Brown in spherical and other molecules obtained from vegetables, it is evident that such motions do not necessarily indicate an animal, but only a kind of attraction and repulsion produced by an uncertain cause. Another argument proves their vegetable nature, these plants give out oxygen, whereas if they were animals they would absorb oxygen and give out azote.

Professor Agardh illustrates his opinion just stated by the following fanciful allusion. When thus fixed he considers these beings as no longer having any animal life, but as preserving the appearance of it, "Like those men of Plato," adds he, "agitated by eternal regret with which the remembrance of a happy life, the sweets of which they formerly tasted, inspires them; always oscillating, never tranquil, they seem aiming at the recovery of that happy life which they have lost." The locomotions, however, of the germes of these Hydrophytes, and their oscillatory movements when fixed, indicate at least a semblance of animality, and an approach to the confines of the animal kingdom.

Leaving, therefore, these doubtful forms, as having no just claim to be considered as animals, I shall now proceed to those whose right to that title is generally acknowledged. And here two very different tribes start up and prefer their claim to be first considered; the *Infusories*, namely, and those which have been called *Polypes* and *Zoophytes*. But since the first of these two classes, by means of one of its tribes, as its great oracle, Ehrenberg, remarks, approaches the oscillating plants,—I shall consider it as the basis on which the Deity has built the animal kingdom. Indeed, though the Polypes at first sight appear most to resemble the higher *plants*, in their general configuration, the Infusories, as well as coming nearer to the lowest by some of their members, in others exhibit no slight analogy to *seeds*.

Of all the groups of animals those of the least consequence, one would think, must be those that for the most part escape the inquiring eye unless aided by a microscope. The infusories, or as they have been also called *animalcules, microscopic animals, acrita* or indiscernibles, *amorpha* or without form, are of this description. These wonderful little creatures, though they are every where dispersed, remain like seeds, without apparent life or motion, perhaps after animation has been suspended for years, till they come in contact with some fluid, when they are immediately reanimated, move about in various directions, absorb their proper nutriment, and exercise their reproductive powers according to the law of their several natures. Yet these little animals, though in some respects they exhibit no slight analogy to vegetables, are not only distinguished from them by their irritability, but likewise by their organization, and powers of locomotion and voluntary action. Their mode of reproduction, however, is not far removed from that of some vegetables; they are spontaneously divisible, some longitudinally and others transversely, and these cuttings, if they may be so called, as in the Hydra or common Polype, become separate animals. They are also propagated by germes, and some appear to be viviparous. The species of *Vibrio* found in diseased wheat by M. Bauer is oviparous, as is evident from his observations and admirable figures. Lamarck indeed regards them as having no volition, as taking their food by absorption like plants; as being without any mouth, or internal organ; in a word, as transparent gelatinous masses, whose motions are determined not by their will, but by the action of the medium in which they move. That they have neither head, eyes, muscles, vessels, nerves, nor indeed any particular determinable organ, whether for respiration, generation, or even digestion. On account of these supposed negative characters, they were called by De Blainville, *Agastria*, or stomachless, as having no intestines; but Ehrenberg, who has studied them in almost every climate, has discovered, by keeping them in coloured waters, that they are not the simple animals that Lamarck and others supposed, and that almost all have a mouth and digestive organs, and that numbers of them have many stomachs. Spallanzani, and other writers that preceded Lamarck, had observed that their motions evidently indicated *volition:* this appeared from their avoiding each other and obstacles in their way; from their changing their direction and going faster or slower as occasion required; from their passing suddenly from a state of rest to motion without any external impulse; from their darting eagerly at particles of infused substances; from their incessantly revolving on themselves without a change of place; from their course against the current; and from their crowding to shallow places of the fluid in which they are: each species seems also to exhibit a peculiar kind of instinct. Lamarck thinks all this delusion proceeding from errors in judgment, and the result of prejudices inducing people readily to believe what accords with their persuasions. But to apply this remark to such observers as Spallanzani, &c., is drawing rather largely on the credulity of his readers, who might very justly change the tables and apply it to himself, who is certainly as much chained by system as any one can be. Admitting that the observations of Spallanzani just stated record facts, it appears clearly to follow from them that these animals *have* volition, and therefore cannot properly be denominated *apathetic*, or insensible. The fact that they almost all have a mouth and a digestive system; many of them eyes, and some rudiments of a nervous one, implies a degree, more or less, of sensation in them all, and consequently that they have all, whether it be molecular and diffused in their substance, or confined to particular organs, I say that they have all a nervous influence and excitement sufficient for their several wants, corresponding with their several natures.

These minim animals may be said almost to be universally dispersed; they inhabit the sea, the rivers, and other waters; are supposed to float in the air; they are found in the blood and urine; in the tartar of the teeth; in animal substances; in vinegar; in paste; in vegetable substances; in fruits, seeds, and grain; in sand; amongst tiles; in wells; on mountains, &c. Their numbers are infinite; hundreds of thousands may be seen in a single drop of water; their minuteness is extreme, some being not more than $\frac{1}{2000}$ part of a line in length, and yet these atoms of animals have a mouth and several stomachs.

Let a man, says Dalyell, the translator of Spallanzani, conceive himself in a moment conveyed to a region where the properties, and the figure and motions of every animal are unknown. The amazing varieties of these will first attract his attention. One is a long slender line; another an eel or serpent; some are circular, elliptical, or triangular; one is a thin flat plate; another like a number of reticulated seeds; several have a long tail, almost invisible; or their posterior part is terminated by two robust horns; one is like a funnel; another like a bell, or cannot be referred to any object familiar to our senses. Certain animalcules can change their figure at pleasure:[1] sometimes they are extended to immoderate length, then almost contracted to nothing; sometimes they are curved like a leech, or coiled like a snake; sometimes they are inflated, at others flaccid; some are opaque while others are scarcely visible from their extreme transparence. No less singular is the variety of their motions;—several swim with the velocity of an arrow, so that the eye can scarcely follow them; others appear to drag their body along with difficulty, and move like the leech; and others seem to exist in perpetual rest; one will revolve on its centre, or the anterior part of its head; others move by undulations, leaps, oscillations, or successive gyrations;—in short, there is no kind of animal motion, or other mode of progression, that is not practised by animalcules.

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[1] PLATE I. FIG. 3.

Their organs are equally various. Some appear to take their food by absorption, having no mouth, to this tribe belong what have been called vinegar eels; others have a mouth and several stomachs, but no orifice for the transmission of their excrements; others, again, have both a mouth and anal passage, and what is wonderful, in such minute creatures, sometimes as many as forty or fifty stomachs;[1] though many are without eyes, others are furnished with these useful organs, some having one, others two, others three, and others four; some have processes resembling legs. In the second Class of these animals, the *Rotatories*, to which the wheel-animalcules belong, the internal organization approaches to that of the higher classes, for they exhibit the rudiments of a nervous system; their alimentary canal is simple; they have a branching dorsal vessel, but without a systole and diastole; their pharynx is usually furnished with mandibles, which are sometimes armed with teeth. The mouth of the majority, especially amongst the rotatories, is fringed with ray-like bristles, which Cuvier thinks are connected with their respiration. This circumstance of a circle of rays surrounding the oral orifice, is found in the polypes and several other animals of a higher grade. Their use in the present instance, I speak more particularly of the wheel-animalcules, is by their rotation to produce a current in the water to the mouth of the animal, bringing with it the still more minute beings which constitute its food.

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[1] *Leucophrys, Enchelis, &c.*

These invisible inhabitants of the visible world created an early interest in inquisitive minds; Dr. Henry Power, and after him the celebrated Hooke, about the middle of the seventeenth century, or earlier, noticed, what were called vinegar eels.[1] Sir E. King, in the *Philosophical Transactions*, described some experiments on the animalcules found in pepper water; and, subsequently, Mr. Harris made observations upon a variety of these minute creatures. The subject was afterwards taken up by various writers, both here and on the continent. Amongst these none was more eminent than Spallanzani. O. F. Müller, who seems to have been the first who treated the subject systematically, embodied these animals in a Class by the name of *Infusories*.[1] He was followed by Bruguiere and Lamarck, who divided it into Orders and Sections. But the system of these zoologists has for the most part been set aside by Ehrenberg, a Prussian naturalist, before-mentioned, who devoted ten years of his life to the investigation of these animals, for which he was particularly qualified by his previous studies and employment, the anatomy of the Molluscans of the Red Sea, by which he had been accustomed to the use of microscopes and micrometers. His researches on the Infusories, during Baron de Humboldt's last journey, extend to more than fifty degrees of longitude, and fourteen degrees of latitude;—he went as far as Dongola in Africa, and the Altai mountains in Asia, and examined these animals in a great variety of situations. He found them on Mount Sinai; swarms of various species in the wells of the Oasis of Jupiter

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[1] *Vibrio Anguilla.*

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[1] *Infusoria.*

Ammon; and at a considerable depth in some Siberian mines, in places entirely deprived of light.

He considers them, it should seem, as forming a Sub-kingdom, which he denominates *Plant-animals.*[1] This sub-kingdom he divides into two Classes. The first, from the number of stomachs,[2] with which the genera belonging to it are furnished, he names, *Polygastrica*, or many-stomached, probably, to contrast with De Blainville's name before-mentioned. The second class he calls *Rotatories*,[3] consisting of the ciliated Polypes of Lamarck;[4] each of these classes he subdivides into two parallel orders, the first containing those that are naked, and the second those that are loricated,[5] or covered with some kind of shell.

In the first of these classes, the *Polygastrics*, the animals recede further from the organization of the higher tribes, and approach nearer to that of vegetables; but in the second, as I before observed, rudiments of the organization of those tribes make their appearance. Many of the former are known to derive their nutriment from vegetable substances, but what the majority subsist upon is not certainly known;—but the latter class, the Rotatories, are ascertained to be predaceous, as above stated. Their mode of drawing their corpuscular food within the vortex of their mouth is thus amusingly illustrated by Spallanzani. As a certain species of whale, says he, *(sic magnis componere parva solebat)* after having driven shoals of herrings into a bay or strait, by a blow of its tail produces a whirlpool of vast extent and great rapidity, which draws the herrings into its vortex; the monster then presenting its open mouth, the herrings are precipitated into its throat, and it is soon satiated: so the carnivorous Infusories produce a vortex by their tentacles, and satisfy their appetite.

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[1] *Phyto-zoa.*

[2] PLATE I. FIG. 1.

[3] *Rotatoria.*

[4] PLATE I. FIG. 2.

[5] See Appendix, note 20.

I have been more diffuse upon the history of the animals whose functions in nature I am next to consider, because to them in a more particular manner, applies Pliny's observation with regard to insects. *In his tam parvis, atque tam* nullis, *quæ ratio, quanta vis, quam inextricabilis perfectio!* In nothing is the power and wisdom of their Almighty Author more signally conspicuous. Organization so complex, and life, and spontaneous motion, and appetite, and means to satisfy it, and digestion, and nutrition, and powers of reproduction in animals of such infinite minuteness! Who can believe it? Yet so it is, and that each of these should be varied in the different tribes and genera—that these less than the least of all the creatures that present themselves to the observation of mankind, and which till within a century or two were not suspected to exist, should out-number beyond all statement of numbers, all the other animals together that people the whole globe, that they should probably enter into us and circulate in our blood, nestle between our teeth, be busy every where, and perceived no where, till the invention of the microscope drew aside the veil between us and these entities, and we saw how God had filled all things with life, and had based the animal kingdom upon living atoms, as well as formed the earth and the world of inert ones. But to us the wondrous spectacle is seen and known, only in part; for those that still escape all our methods of assisting sight, and remain members of the invisible world, may probably far exceed those that we know.

We may conclude that this vast, or rather infinite, host of animalcules was not created merely to be born and die; was not sown, as it were, over every part of the earth's surface, lurking in seeds, and other vegetable and animal substances, till coming into contact with fluid matter of whatever description it starts into life, and swarming in the ocean, and its tributary streams; it was not thus dispersed every where, either alive, or in a state to revive and live, but for some great purpose, for which its organization, structure and station amongst animals, particularly adapt it.

With respect to its immediate action upon the vegetable and animal kingdoms, it has been ascertained, as to many species, that they ascend with the sap in vegetables,[1] and are found in the blood and excretions of animals,[2] who knows but they may act an important part in the animal frame; somewhat similar to what devolves upon the larves of certain insects, with regard to stagnant waters, they may be *depurators* where they are thus employed, and contribute to preserve a healthy action. It is true, as far as vegetables are concerned, especially grain, they appear to destroy, where they take up their residence, but when we discover the same or similar species, in sour paste or vinegar, they seem destined to consume substances that cease to be wholesome; and in fact, in all fluids, in which they usually so abound, they may be destined to fulfil a similar office, and it is a remarkable circumstance in their history confirmatory of this idea: that these animals, though animation in them is often suspended for a long time; when they swarm in infusions, having fulfilled their office, perish in a few days.

It is probable that in the waters of our globe an infinity of animal and vegetable molecules are suspended, that are too minute to form the food of even the lowest and most minute animals of the visible creation, and therefore an infinite host of invisibles was necessary to remove them as nuisances.

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[1] Mr. Bauer found *Vibrio Tritiri*, in the stalk as well as in the ear and grain of plants of wheat, which were raised from seeds inoculated with it. *Phil. Trans.* 1823. 3.

[2] See above, p. 152.

But the principal point, and that in which their utility most evidently appears, is their furnishing a principal portion of the food of innumerable animals of a higher order than themselves. Those infinite armies and forests of locomotive and fixed Polypes, that give to the ocean one of the features that distinguish earth, have their mouths surrounded with tentacles, when expanded assuming the appearance of so many blossoms, with these they collect their food, which, amongst the more minute ones, consists often of our Infusories. A single stem of these compound animals, having often innumerable oscula or mouths, requires a vast supply of food; others equally compound, as the Ascidians or Alcyons, by alternately absorbing and expelling the sea water, draw in with it a supply of animal food, consisting, in part, of the creatures in question, which abound in the oceanic waters; some of these have a common organ for this purpose, and in others each individual of the system is fitted with one; the Molluscans and an infinity of the smaller inhabitants of the ocean, doubtless also derive a considerable portion of their nutriment from them, the minute Crustaceans probably do the same, and many insects, whose larvæ inhabit the waters, some by producing a vortex like the rotatories,[1] thus find an abundant supply to carry them to their intermediate state. But not only do these creatures furnish the more minute animals that inhabit the waters, with a considerable portion of their food, but, it should seem, even some of those that are of a higher grade, and larger stature. Whoever has been in the habit of keeping gold and silver fish,[2] in glass or other vessels, is aware that they require no other food than a fresh supply of water every second or third day. Their nutriment therefore must be derived from what they find in the water. In this may often be seen minute Branchiopods swimming here and there, sometimes with a bundle of eggs appended to each side: but these are not sufficiently numerous to form the whole of their food, the water must therefore contain other nutritive substances which may contribute to their subsistence, and as it is known that various infusory animalcules inhabit it, we may conclude that they are inserted in their bill of fare. It has been observed by an eminent writer, speaking of the gold fish, "The water, when care is taken to renew it frequently, appears sufficient for the nutriment of these fishes during many months; but it should be considered that though this water appears to us very pure, it always contains a multitude of animalcules and very minute plants, which the fishes are continually swallowing."

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[1] *Culex, Stratyomis, &c.*

[2] *Cyprinus auratus.*

When Creative Wisdom covered the earth with plants, and peopled it with animals, he laid the foundations of the vegetable and animal kingdoms with such as were most easily convertible into nutriment for the tribes immediately above them. The first plants and the first animals are scarcely more than animated molecules,[1] and appear analogues of each other; and those above them in each kingdom represent jointed fibrils.[2] It is singular and worthy of notice, that the Creator after the creation of inanimate matter, probably first imparted the living principle to bodies of the same form with the molecules and fibrils into which that matter is resolvable, thus uniting, by common characters, things essentially distinct, and preserving unbroken that wonderful chain which links together all created things.

Every body, who has eyes, is aware, that vegetation takes place upon almost every substance, upon the bark of trees, upon naked rocks, upon brick walls and tiled roofs, and even upon glass when not constantly cleaned. The first plants, that take on these their station, usually look like green or yellow powder, when they decay forming a little soil, in which others more conspicuous find sufficient nutriment, and so one succeeds another till a sufficient portion of soil covers the rock, &c. to afford the means of life and growth to more perfect plants, and often to arborescent ones. An analogous process takes place in the water. The *matière verte* of French authors makes its appearance, and other Hydrophytes, in conjunction with the Infusories, form as it were a first soil for the support and maintenance of animal life, both for those which derive their nutriment from vegetables, and those that feed on beings of their own class. Thus a maintenance is provided for higher forms, and, at last, for the highest; and a table is spread, both on the earth and in the waters, for every living thing, from that which the eye cannot discover, to man, the head and king of all.

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[1] For instance, *Globulina* and *Monas*.

[2] *Oscillatoria* and *Vibrio*. See Appendix, note 21.

How wonderful and adorable is that Almighty Being, who thus made all things dependant upon each other, and based the visible world, in the three great departments into which we see it divided, upon an invisible basis, and in which cohesion and life are maintained by those powers which God has placed as rulers in the physical world, and by which he still acts upon the universe of existences.

Chapter V.

Functions and Instincts. Polypes.

The tribe of animals to which we are next to direct our attention, though not invisible like the last, are almost equally concealed from our view by the medium that they inhabit; so that, with the exception of those that abound in fresh water, and are easily kept alive for examination, the great body of them inhabiting the ocean, can seldom be studied in a living state. All the polypes are aggregate animals, in which they differ from the majority of the preceding class. The most imperfect of them, as the sponges and some of the alcyons, seem to consist merely of a gelatinous mass, without any organs of prehension, which by its alternate contraction and dilatation, imbibes or sends out the water from which the animal derives its nutriment; but the great majority have a mouth furnished with arms or tentacles varying in number. These are described as tubes, filled with fluid, expanding at the base into a small cavity, which when contracted necessarily propels the fluid into the tentacles, and thus extends them; but when the tube contracts, the fluid flows back into the cavity, and the points of the tentacles converge over the mouth.

These parts are not only organs of sense, but also serve many other purposes, particularly those of prehension and motion; and they very probably assist in respiration, which appears evidently connected with the alternate contraction and expansion of these animals. They are also so constructed as to lay hold of every substance that floats within their reach, whether by means of any gummy excretion like bird-lime, as some suppose, or whether they are furnished with very minute suckers by which they can adhere to any substance, has not been ascertained. Trembley observed, that when the common polype of fresh water touched any little animal with one of its long tentacular arms, it was immediately arrested, and in spite of the most violent efforts to liberate itself, which he compares to those of a fish that had been hooked, was held fast, and carried to the mouth of the polype and swallowed.

The body of polypes is formed of a kind of inspissated mucus, with confusedly agglomerated, and probably nervous, molecules equally distributed; it is covered by no skin, is extremely contractile, and forms an alimentary sac open at one end, serving both for mouth and anal passage. The equal distribution of nervous molecules through the whole substance of these animals, will account for their extreme tenacity of life. In fact, this uniform gelatinous mass, which is without any organized structure, may be regarded as a kind of primary substance, which possesses characters, in some respects, common to both animal and vegetable matter.

This substance without any nervous centre—though nervous influence, one would think must be in most force round the orifice where the tentacles are in action,—yet full of cerebral matter, sensible to the light without any organ of sight; extremely irritable; alternately contracting and expanding, and thus moving without any apparatus of muscles; with no trace of organization but the tubular rays that surround its mouth, which appear to perform the office of eyes, hands, feet, and lungs; this singular substance lends a clue to form the class into *Orders* according to the circumstances in which it is placed.

1. In the common *Polypes*[1] of our ditches and stagnant waters, it is a naked branching elementary sac or canal, without any internal support, and endued with powers of locomotion.

2. In the *Madrepores* and others,[2] its Maker for mighty purposes has enabled the animal to form for itself a fixed calcareous house or polypary

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[1] *Hydra viridis, fusca,* &c.

[2] *Lamellifera,* Lam.

as it is called, consisting often of innumerable cells, each containing a separate individual with its mouth and tentacles, united to the general body at its other extremity, and each with an external aperture, by which they are protruded, and expand like a flower.

3. In the *Coral* and affinities,[1] it forms an internal calcareous axis, which it envelopes as the bark does the tree: it is fixed by its base like the preceding tribe; and from this crust, or bark, the tentaculiferous mouths of the polypes emerge. In some the axis appears articulated.

N.B. In these two last the base by which the compound animal is fixed to rocks, or other substances, expands like the base or root of a tree; and by their ramifications these polypes, whether the polypary is external or internal, resemble its branching stem.

4. The *Sponges*[2] and *Alcyons*[3] have been generally arranged with the last Order, but, from M. Savigny's observations, it appears that certain of these animals have neither stomach, mouth, nor tentacles, the animal life of which he thinks might be disputed; but Mr. Bell has discovered that they alternately imbibe and expel that fluid, which seems to prove their animal nature. Perhaps they ought to be con-

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[1] *Corticifera*, Lam.

[2] *Spongia*.

[3] *Alcyonium*.

sidered as nearer to vegetable matter than the other polypes.

5. Other *Alcyons*[1] seem to have a more complex organization than any of the preceding polypes; they are stated to have eight parallel stomachs. Only four genera belonging to this Order have been described, and its proper station seems doubtful.

6. In the *Sea-Pen*, and others,[2] the animal envelopes an axis, as in the third Order, and has a tentacular mouth, but it is not fixed by its base. The greater part of these animals float in the waters, but others remain at the bottom, either upon the surface or partly plunged in the sand.

Polypes are invariably aquatic animals, some inhabiting fresh water, but the great body are marine, and most numerous in tropical seas. In very high latitudes, only cellarians,[3] sertularians,[4] alcyons, and some sponges occur, and in the vicinity of volcanic islands in the Polar seas, corallines and gorgonians. These multiply a little from 6° to 9° N. L.: then, as they approach the tropics, the coral reddens, and the madrepores whiten, and at 33° they attain their full powers of growth and multiplication. Some frequent the mouths of rivers, where there is a conflux of fresh and salt water. Some love atmospheric influence, while others avoid it. The marine ones frequently plant themselves on rocks, in different aspects, often regulated by the climate. They rarely expose themselves to violent currents, or the direct shock of the waves. They are often found in the hollows of rocks or submarine grottoes, and in gulfs where the water is less agitated.

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[1] *Polypi tubiferi*, Lam.

[2] *Polypi natantes*, Lam.

[3] *Cellaria*.

[4] *Sertularia*.

It was observed above that the Infusories present some analogy to the seeds of vegetables; the polypes go further, and represent, often most exactly, the developed plant from the tree, by almost all the intermediate stages, to the fungus,[1] at least the fixed polypes: these appear, as it were, to take root, to send forth branches which produce seeming blossoms, composed of what appear to be petals arising from a calyx, arranged sometimes in a single and at others in a double circle, and in some including the semblance of stamina; they are also very sensible to the light, and turn to its source, and like plants are readily propagated by cuttings and buds; so that all the older naturalists regarded them as real plants, without apparently suspecting their animal nature. Ancient naturalists were very apt to mistake analogical resemblances for proofs of affinity, but in the progress of science, when natural objects were submitted to a stricter examination, more correct ideas were substituted for these mistaken ones, and the zoophytes, or polypes, were generally admitted to be real animals, though some, after Linné, still regard them as something between animal and vegetable. Trembley was one of the first who ascertained their animal nature; he saw the fresh-water polypes,[1] by means of their long tentacles, seize and swallow certain grubs, and also many minute *Entomostracans*, common in stagnant water. These polypes so used their tentacles as evidently to indicate a degree of volition, sometimes using one and sometimes many, as circumstances required. When they had secured their prey, they contracted and gave a curve to these organs, so as to bring it near the orifice, or mouth, at their anterior extremity, which then began to open, and the animal they had caught was gradually absorbed. He has seen them attack small fishes, also worms, larvæ and pupæ of gnats, parts of slugs, entrails, and even pieces of meat.

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[1] Plate II.

The marine polypes are equally ravenous with the river ones, feeding upon whatever they can lay hold of, sometimes, like the wheel-animals, or rotatories, producing a vortex in the water, and thus causing a flow to their mouth of the infusory, and other animalcules contained in that element. It is to be observed that these inhabit a common house, from which they cannot separate themselves; their sole character is that of being attached to an animated mass, so that each individual partakes of the life common to the whole, and also of a separate life, independent of that of the others. Yet the nutriment that one of these individuals takes, extends its influence to parts the most distant from the place it occupies.

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[1] *Monoculi.*

Having made these general remarks, I shall next give a history of some of the best known and most interesting species.

1. The common polypes of stagnant waters, belonging to the *first* Order, have met with an admirable historian in M. Trembley, and what I have to communicate with respect to them will be chiefly derived from him. With regard to their *reproduction*, it is by germs and cuttings. The former issue gradually from the body of the parent polype, as the trunk of a tree sends forth a branch. The bud that forms the commencement of a young one, is a continuation of her skin, and its stomach of her stomach. When she takes her food, the bodies of her young are seen also to inflate themselves as if they had taken it with their own mouths, and the food may be seen passing from one to the other. After they have grown thus as branches for some time, and even have pushed forth germes themselves,

they detach themselves from the parent stem, and become separate animals.

It is stated that, by this mode of generation, in the space of a month a single polype may be the parent of a million of descendants. Trembley observed some long branches of trees that had fallen into the water, which he describes as being as full of polypes as a peruke of hairs; and that though their innumerable arms were at work, there was no confusion amongst them.

But these animals, as is well known, do not multiply solely by germes, but also by cuttings, as they may be called; their substance is so instinct with life, that nothing appears able to destroy it—a circumstance, perhaps, arising from the nervous molecules of which it seems almost to consist. If divided transversely, each segment will become a distinct animal, send forth tentacles round its upper aperture, and close the lower one; if it is divided longitudinally, each half will form a separate tube in an hour, and begin to ply its tentacles in a day; even if divided into longitudinal strips, instead of the sides turning in, as in the former case, each strip becomes inflated, and a tube is formed within it: and what is still more wonderful, and seems next to a miracle, these animals may be turned inside out, like the finger of a glove, without destroying either their vitality, their power of producing germes, and of catching, swallowing, or digesting their food: so that they have, properly speaking, neither a *within* nor *without*, both surfaces of their alimentary canal being equally fitted for digestion. This, however, is not so entirely anomalous as it may at first sight appear; for cuttings of some vegetables, if planted inversely, will take root, the top bearing the root, and the bottom the branches and inflorescence.

The fresh-water polype usually remains fixed by its closed extremity to one spot, from which it seldom moves, exhibiting no other trace of an animated being than the motions of its arms; but when the want of light or heat causes it to shift its quarters, it moves slowly by fixing alternately, like a leech, its head and tail to what it is moving upon.

The majority of the *marine polypes* are attached, in some way, to a calcareous support formed by themselves, which is called by Amoureux, Lamarck, and other continental writers, their *Polypary*;[1] and they are none of them locomotive except the last order.

4. The polypes of the *second* Order, the sheathed polypes of Lamarck,[2] as the most important and interesting of this class of the animal kingdom, I wish to leave last upon the reader's memory. I shall, therefore, next make a few brief observations upon those sponges and alcyons

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[1] Fr. *Polypier*.

[2] *Polypi vaginati*.

that have no tentacles, and form the *fourth* Order. These are included by Lamarck amongst those just mentioned, but they appear not properly to belong to them, and to have a still more simple organization. In this tribe, as was before observed, nutrition seems carried on by a kind of systole and diastole, the sea water being alternately absorbed and rejected by the tubes composing the substance of the sponge, they having no organs to collect their food in any other way.

Many of these productions are remarkable for being hollowed internally, and in their external shape resembling cups, bowls, and vases: several gigantic specimens of this kind were collected in India by the late lamented Sir Stamford Raffles, to whose indefatigable exertions, judicious arrangements, and uncommon ardour in her cause, science is so deeply indebted, and presented by him, with the rest of his valuable collections, to the Museum of the Zoological Society, where they are now to be seen. Their general structure also, as well as form, fits them for receiving a large quantity of water, as well as for parting with it, in proportion to the pressure, when received: in the living animal, this pressure is produced by its expansion.

What particular function, or office, has been devolved by the All-wise Creator upon these zoophytes, which are produced so rapidly, and in such numbers, on the bed of the ocean and its rocks, has not been ascertained. As in the case of a vast variety of other marine animals, they probably derive their nutriment from the contents of the water absorbed by their tubes; they may contribute their part to the depuration of the oceanic waters, and to the maintenance of the equilibrium amongst their inhabitants, however minute, which is necessary to the general welfare. Doubtless, in their creation, He, who inhabiteth Eternity, to whose view all time as well as all space is present, had in view the benefit of his creature man, to whom they form a very useful present, and which he has long applied to his purposes. Sponges were in use as early as Aristotle's time, when the people that employed themselves in collecting them observed, that when they attempted to pluck them up they appeared to resist, whence they concluded they had some sensation.[1] They now form a very considerable article of commerce. The fishery for them is chiefly carried on in the Mediterranean, particularly in the Grecian Archipelago. The collection of them is attended with danger, as they are fixed to the rocks at the depth of several fathoms, so that the sponge-fishers must be excellent divers. Tournefort says, that no youth in these islands is allowed to marry, till he has given proofs of his capacity in this respect.

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[1] Aristot. *Hist. Anim.* B. i. c. 1, comp. B. v. c. 16.

Amongst plants, as Mr. W. S. Mac Leay has, I think, remarked, sponges present some analogy to the puff-balls.[1]

5. A *fifth* Order of polypes, worthy of attention, is that to which the *red coral* belongs, in these the animal instead of being covered, or in any way sheltered by its polypary, invests it completely, so as to form a kind of bark over every part of it; on this account the name has been changed by writers on these animals, and it is denominated their *axis*, since upon it they are, as it were, suspended, and run their prescribed race. This axis consists of a much more rigid, solid and lapidose substance, than the polypary of the really *sheathed* polypes, presenting when polished the smooth substance and lustre of marble, without any appearance of pores or other orifices—when broken it exhibits the same kind of fracture as a stick of red sealing-wax; this description refers particularly to the red coral,[2] for in some other genera belonging to the Order the axis is jointed,[3] and in others, very flexible.[4] The sheathed corallines appear in some sort, to be analogues of those animals whose bodies are covered and defended by an external crust or shell, like the Testaceous Molluscans, the Crustaceans and the Insects; while the tribe in question,

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[1] *Lycoperdon.*

[2] *Corallium.*

[3] *Isis, &c.*

[4] *Antipathes, Gorgonia.*

especially those having a jointed axis, present some analogy to the vertebrated animals, in which the muscles cover the bones. It should seem, from the solid and compact substance generated by them, that these Polypes absorb from the sea-water a greater quantity of the matter which is converted into carbonate of lime than the rest of the class, so as to enable them to condense it into the smallest compass, and therefore Providence has gifted them with the faculty of making up in *virtue*, so to speak, what they may want in *volume*. A single-stemmed species, however, belonging to the flexible genus *Antipathes*, found by Professor Eschscholtz, on the north-west coast of America, was ten feet long. The foot, or base by which the common coral is attached to the rocks, as indeed is the case with the whole section to which it belongs, is remarkably expanded; it rises at first with a single stem of varying magnitude, which soon divides into a small number of branches, in their turn dividing and subdividing irregularly into a great number of others, so as to resemble a leafless shrub, rising to the height of about eighteen inches. After pearls, this is the most precious production of the ocean, and has always been a valuable article of commerce. As well as the common sponge, it is principally the produce of the Mediterranean, and is formed with such rapidity, that a place which has been quite exhausted by the coral fishermen, in the course of a very few years, is again replenished with it. It is probably enabled, by its broad well fixed base and rigid axis, to withstand the violent action of the strong currents of the sea just mentioned.

6. The *Floating Polypes*, which form Lamarck's last order, chiefly differ from the coral in being locomotive, and sometimes swimming freely about in the sea, though some usually remain stationary, but never fixed. Their oviform germes, like those of many other marine polypes, are ejected by the mouth. The most noted species, from its singular resemblance to a quill with its plumes, is called the sea-pen.[1] It is a phosphoric animal, and emits a light so brilliant that by it the fishermen can see the fishes swimming near it, so as to be able to cast their nets.

The vast number of marine animals that are endued with the remarkable faculty of emitting light, indicate that it answers some important purpose in their economy. A fact observed by the celebrated Navigator Peron, renders it probable that its object is defence; he remarked that when the Atlantic Pyrosome[2] was irritated, as well as when it was contracted, its phosphorescence was augmented. A variety of hypotheses with respect to the phosphorescence of the ocean have been started; at first it was attributed to the revolutions of the earth, to electricity, &c.; then to putrescent marine animals, which certainly do emit light; but it is now generally known to be the property of a variety of the more frail inhabitants of the deep, and the above remark renders it extremely probable that it was given them by their Creator, to defend them from the attack of their enemies, whom a sudden augmentation of the intensity of their light may frighten from their purpose.

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[1] *Pennatula argentea.*

[2] *Pyrosoma atlanticum.*

2. But the most celebrated polypes, and those which produce the most wonderful effects in some parts of the globe that we inhabit, belong to the section in which the polypary is lamelliferous, or having the star-shaped oscula, or mouth, from which the polype exerts its tentacles, lamellated or divided into various channels, separated from each other by elevated processes, resembling the gills of a mushroom: these, with several others related to them, Linné regarded as belonging to *one* genus which he denominated *Madrepora*, but which Lamarck has divided into *eighteen!* It is amongst the species of this genus, even as circumscribed by the author just mentioned, that we are to look for the polype, which is instructed by its Creator, not only to erect rocky reefs of vast extent and wonderful solidity—which often arrest and perplex the course of the navigator, and greatly increase the perils of navigation—and submarine mountains

that keep gradually diminishing the mass of waters, but also islands, which emerging from the ocean, in process of time are covered with vegetation, and fitted to receive and maintain an animal population with man at their head. The species principally engaged in this great work is the coral, called by Linné the *muricated Madrepore*,[1] and generally known by the name of *white coral;* but Lamarck seems not to have been satisfied as to this species, since it is excluded from his list of madrepores, though he refers to four, if not five, varieties of it as distinct species. Its polype, though so celebrated for its wonderful works, seems to be unknown. Rumphius however has described that of the *fungus Madrepore*, and recently an Italian, Vincent Rosa, whose description I shall copy, another species.

" From every cell," says he, " issues a cylindrical animal, resembling an intestine, transversely wrinkled, about half an inch long and two lines in diameter, and of which the upper extremity or mouth is surrounded by about twenty-two very short tentacles. These animals, which are pendent, because this madrepore is always fixed under the projections of the rocks, and vibrates at the will of the waves, are always of a lively orange colour, they contract as soon as they are touched, and they die upon being taken out of the water." Whoever examines a fragment of the polypary of any of the varieties of white coral, will find it to consist of innumerable radiating tubes, variously intercepted, all of which appear to issue from a common base; these are the receptacles of the general body of the polype, while the connected individuals with their blossoms inhabit an infinity of cells opening externally, from which the tentacles issue to collect their food.

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[1] *Madrepora muricata.* PLATE II. FIG. 1.

The seemingly insignificant creatures here described, and which seem as little animalized as any animal can be to retain a right to the name, all whose means of action are confined to their tentacles, and whose sole employment appears to be the collection and absorption of the beings that form their food, are employed by their Creator, to construct and rear mighty fabrics in the bosom of the deep. He has so organized them, that from their food and the waters of the ocean, which by a constant expansion and contraction they absorb and expel, they are enabled to separate, or elaborate, calcareous particles with which they build up, and are continually enlarging, their structures; forming them into innumerable cells, each inhabited by an individual animal, which however is not insulated and separated from the parent body, but forms a part of a many headed and many mouthed monster, which, at every oral orifice, is collecting the means of still increasing its coral palace, and thus it goes on till it has formed a habitation, not for itself, but, as I said, for man, in the midst of the world of waters.

One of their most celebrated historians, Amoureux, thus expresses himself upon this part of their history. "Some, by their union or aggregation, form a long narrow ridge or reef, which extends uninterruptedly several degrees, opposing an immovable rampart to the great currents of the sea, which it often traverses, the solidity and magnitude of which increases daily. Sometimes this line of madreporic rocks assumes a circular form; the polypes that inhabit it gradually elevate their rocky dwelling to the surface of the sea, working then in a sheltered basin, they by little and little fill up its voids, taking the precaution, however, to leave in the upper part of this impenetrable wall openings by which the water can enter and retire, so as to renew itself, and furnish them with a constant supply of their aliment, and of the material with which they erect their habitation."

They do not always elevate their polyparies from the depths of the waters to their surface, some extend themselves horizontally upon the bottom of the sea, following its curvatures, declivities, and anfractuosities, and cover the soil of old ocean with an enamelled carpet of various and brilliant colours, sometimes of a single colour as dazzling as the purple of the ancients. Many of these beings are like a tree which winter has stripped of its leaves, but which the spring adorns with new flowers, and they strike the beholder by the eclat of petal-like animals, with which their branches are covered from the base to the extremity.

Captain Beechey has given a most interesting account of the proceeding and progress of these animals in erecting these mighty works, and of the manner in which the sea forms ridges, when the animals have carried their work as high as they can : upon these at length a soil is formed beyond the reach of its waves; a vegetation next commences, in time plants and trees spring up, animals arrive, and man himself finds it a convenient residence. His account is too long to copy, I must therefore refer the reader to it, but I must give here his statement of some proceedings of these animals, which have a bearing upon the principal design of the present work, and seem to indicate an instinctive sagacity in the polypes far above their rank in the animal kingdom, and quite inconsistent with their organization.

Speaking of Ducies Island, a formation of the coral animals, he describes it as taking the shape of a truncated cone with the face downwards, the form best calculated to resist the action of the ocean, and then proceeds to say, "The north-eastern and south-western extremities are furnished with points which project under water with less inclination than the sides of the island, and break the sea before it can reach the barrier to the little lagoon formed within it. It is singular that these buttresses are opposed to the only two quarters whence their structure has to apprehend danger, that on the north-east, from the constant action of the trade wind, and that on the other extremity, from the long rolling swell from the south-west so prevalent in these latitudes; and it is worthy of observation, that this barrier, which has the most powerful enemy to oppose, is carried out much farther and with less abruptness than the other." We should feel some surprise if a bee, in the construction of its comb, should strengthen the points most exposed to injury; but that an animal apparently gifted with the lowest degree of sensation, and no intellect, should know where to erect buttresses so as best to provide for the security of its structure indicates in a striking degree the superintendence of Providence directing its blind efforts and unconscious operations.

After considering all the wonderful facts here stated with regard to the proceeding and progress of these seemingly insignificant animals, a speculative imagination may not only picture to itself, with respect to any group of coral islands, its conversion into one vast plain, yielding forests of bread-fruit and other trees, and ultimately sustenance to a numerous population, and a variety of animals subservient to their use, but taking a wider range and still further enlarging its view, might behold the tropical portion of the vast Pacific, not only studded with these islands, but exhibiting them in such frequent clusters and so large, as almost to form a kind of bridge of communication between Asia and America. Indeed, at present, we know not how far these founders of islands may have been concerned in rearing a considerable portion of those continents that form the old world. Calcareous strata and ridges occur every where, and though other causes may have contributed to their formation,[1] yet it is not improbable, that at the time when our northern climates were inhabited by tropical animals, our seas also might abound in madrepores, &c. which might bear their part in the erection of some of our islands.

Professor Buckland, in the appendix to Captain Beechey's Voyage, states that even within the arctic circle there are spots that can be shewn to have been once the site of extensive coral reefs. The old coral reefs that existed previously to the deluge, by that great catastrophe, in many cases, might be formed into chalk ridges. This indeed seems proved by the remains of marine animals, especially sea-urchins, which from this circumstance the common people know by the name of *chalk-eggs*, and which, we learn from Captain Beechey, abound on the submerged ledges of some coral Islands; and at the same period, it is surely no improbable supposition, under the directing hand of Him who willed to destroy the earth by the waters of a flood, and at the same time determined, according to the good pleasure of his will, the precise mode of its renovation, that in the course of the rise, prevalence, or subsidence of the mighty waters, which, for the principal part of a year, acted with irresistible force upon the earth, considerable additions might be made from the debris of the earth's disrupted crust, to the reefs of coral that were left unsubverted, and so many islands be formed or enlarged.

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[1] See Lyell's *Geol.* 1. 130. 210.

When the Creator formed the coral animals, what foresight, as well as power and wisdom did he manifest! That a minute pouch of animated matter, with no other organs than a few tentacles surrounding its mouth, should be fitted to secrete calcareous particles from food collected by it, to transpire or regurgitate them so as to construct for itself a limestone house, that it should be empowered perpetually to send forth germes that could also act the same part; and thus in process of time, by their combined efforts, build up in the midst of the fluctuating ocean, not merely insignificant islets, but whole groups of islands, which in due time are rendered fit for the habitation of man himself, and do in fact become his permanent abode—but not only this, but should so order all other circumstances connected with this procedure, as, for instance, the action of the waves and winds upon this nascent little world, that when the animal has built up to that point, which its nature, for it cannot exist when removed from the influence of its native element, enables it to attain, should take up the wonderful work and complete the design of the Great Creator, and give the structure its due elevation and consolidation, should furnish it with fountains and streams of water; should cover it with a soil capable of affording sufficient nutriment to trees and plants, which should in their turn afford food for some part of the animal kingdom, and finally for man himself. How evidently does all this shew the adaptation of means to an end. What a number of calculations must be made, what a number of circumstances taken into consideration, what a number of contingences provided against, what a number of conflicting elements made to harmonize and subserve to the promotion of a common purpose, which it is impossible could have been effected but by the intervention and constant guidance of an unseen Being, causing all things so to concur, as to bring about and establish what he designs! And, when we further consider the multiplicity of aspects in which the subject must be viewed, in order to get a clear and correct idea of the co-operation of so many causes, seeming often at variance with each other; we may further affirm, without fear of contradiction, that the whole must be the plan and the work, as the primary and only intelligent cause, of a Being infinite in power, wisdom, and goodness.

There are two circumstances in the above account of the proceedings of these animals, that more particularly demonstrate Divine interposition. One is the precaution to which they have recourse when they build a circular reef in the sea, that they leave an opening in this part for the entrance of the tide and its reflux, so that a constant renovation of the waters takes place, without which they could not proceed in their operations, for want of their necessary aliment.

The other is, not only that they erect their buildings in the form best calculated to resist the action of the ocean, but also erect break-waters to strengthen the weakest points, and those from which the greatest danger is to be apprehended.

It is clear that beings so little organized, with scarcely any sense or feeling, are not sufficient of themselves to take these precautions, they must be directed and impelled by some power acting upon them; which, foreseeing the want, provides for it; this can be no physical power, for that is equally without intelligence, and acts necessarily, but it must be the result of the will and original action of Supreme Intelligence, who either so organized the animal as to direct it to certain acts, when placed in certain circumstances, by the agency of physical powers; or by his own immediate employment of these powers, influenced its action, as the occasion required.

I cannot conclude this history of the Polypes without adverting to another circumstance which proves in a very striking manner the intervention of the Deity: and that they could not have assumed the various forms under which we behold them, from peculiar circumstances, to the influence of which, in the lapse of ages they were exposed. When we see animals, buried in the bosom of the ocean, symbolize the whole vegetable world from the tree to the moss and lichens that vegetate on its trunk, and the agaric or other funguses that spring up beneath it, we are naturally led to inquire into the reason of this system of representation, exhibited by beings that have no affinity, nor are even contrasted with each other by juxta-position.

One of the general objects of the vegetable kingdom was to ornament the dry-land with what was *fair to look upon*, as well as with what *was good for food*. But the depths of ocean, though planted with various vegetables, seem unapt to exhibit in beauty the frail blossoms of the plant, which though they can bear the fluctuations of their own atmosphere, must often be destroyed by the greater weight and more irresistible agitations of a denser element. To ornament the bosom of the deep, therefore, more solid forms, sending forth blossoms capable of sustaining the action of such an element, were requisite: and therefore God, who gifted his creature man with an inquiring spirit, and with an appetite for knowledge of the works of creation, to furnish him with objects for inquiry, and to gratify that appetite to the utmost, not only placed before his eyes upon the earth an innumerable host of creatures, of which he could gain a notion by only opening his eyes and by observing their beauties, and experiencing their utility, might praise his Maker for them; but also filled the deep with inhabitants, and ornamented it with animals that appeared to vegetate and blossom like plants, that his curiosity being excited, he might also study the inhabitants of the water, and glorify his Maker for the creation of them also.

But we may derive another use from the consideration of these plant-like animals, if the sceptic endeavours to persuade us, from the gradual progress, observable in natural objects from low to high, and from the narrow interval that often separates those in the same series from each other, that by the action of certain physical causes, consequent upon certain established laws and a fixed order of things, and by the stimulus of certain appetencies in themselves, animals gradually changed their forms and organization, and thus, by slow degrees, kept improving in all respects, till at last the monkey became the man, if the sceptic thus attempts to pervert us, we may turn round upon him, and ask him, how it was that the zoophyte, buried in the depths of the ocean, should imitate the plant? can a studied imitation every where denoting purpose and design, a mighty structure including innumerable forms and parts connected with each other and formed evidently according to a preconceived plan, be the result of the operation of blind, *unguided* physical agents, acting by the appetencies of these organized beings? How indeed could they have any appetency to put on the appearance of a set of objects they never saw? The thing is morally impossible. In fact, when we survey the whole series of natural objects, and find throughout a system of representation, as well as a chain of affinities, it is as clear as the light of day, that an infinite Intelligence must first have planned, an Almighty hand then executed, and that infinite Love still sustains the whole.

CHAPTER VI.

Functions and Instincts. Radiaries.

IT happens not seldom to the student of the works of creation, when he is endeavouring to thread the labyrinth of forms in any of the three kingdoms of nature, and has arrived at any given point, to feel doubtful which course to pursue. The road divides, perhaps, into two branches, which both promise to lead him right. At the very outset of the animal kingdom, as we have seen, there was some uncertainty, whether we should begin by the Infusories or Polypes, and now the Tunicaries, or Ascidians as some call them, at the first blush seem more closely connected with the Polypes, than the Radiaries, which Lamarck has placed next to them; but when we consider that the organization is much more advanced in the former than in the latter, not only in the organs of digestion, but in those of sensation, respiration, and circulation, we feel satisfied that the latter, where the object is to ascend, should first be considered. I shall, therefore, now give some account of the *Radiaries*.

The animals forming this class receive this appellation, because they exhibit a disposition to form *rays*, both in their internal and external parts, a disposition which begins to show itself, as we have seen, both in the polypes and the infusories[1] with respect to their oral appendages, and is found also in the tunicaries and cephalopods, or cuttle-fish. And this tendency in the works of the Creator to produce or imitate radiation, does not begin in the animal kingdom; the Geologist detects it in the mineral, and the Botanist in the vegetable, for Actinolites, Pyrites, and other substances exhibit it in the former, and a great variety of the blossoms of plants in the latter. We may ascend higher, and say that irradiation is the beginning of all life, from the seed in the earth and the *punctum saliens* in the egg, to the fœtus in the womb; and still higher in the physical world, sound radiates, light radiates, heat radiates. If we further survey the whole universe, what do we behold but radiating bodies dispersed in every direction. Suns of innumerable systems, shedding their rays upon their attendant planets; and the Great Spiritual Sun of the universe, even God himself, is described in Holy Scripture as that awful Being, "*Whose goings forth have been from of old, from everlasting.*"

Cuvier, and after him several other modern Zoologists, have considered Lamarck's Class of Radiaries as forming a group or class of the zoophytes; but when we recollect that they cannot, like the infusories and polypes, be propagated by cuttings and offsetts, this seems to indicate an animal substance in which the nervous molecules are less dispersed, and that some tendency to nervous centres has been established. In the upper classes of invertebrated animals, indeed, many will reproduce an organ when mutilated, and some even a head, but none but the polypes and infusories multiply themselves in the way above stated. It seems, therefore, most advisable to adhere to Lamarck's system, by considering the animals in question, as forming a group by themselves, and to adopt his name of *Radiaries*.

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[1] See above, p. 154, 166, &c.

These are distinguished from the class immediately preceding, the polypes, by being limited as to their growth to a certain standard, as to their form by the general appearance of radiation they usually present, being either divided into rays, as in the star-fish; or having rays exhibited by their crust as in the sea-urchins; or embedded in their substance, forming appendages to their viscera, as in the sea-nettle or jelly-fish. They have not, like the polypes, a terminal mouth or orifice surrounded by food-collecting tentacles; but one placed, most commonly, underneath their body. Their digestive organs are distinct and more complex. They are never fixed, and are to be met with only in the sea and its estuaries. Lamarck has divided this class into two orders, the *Gelatines*[1] and the *Echinoderms.*[2]

1. The *Gelatines*, which some consider as a distinct class under the name of *Acalephes*,[3] are distinguished by a gelatinous body, and a soft and transparent skin; they have no retractile tubes issuing from the body; no anal passage; no hard parts in the mouth; and they have no interior cavity, their viscera being imbedded in their gelatinous substance.

Some genera[4] in this Order, like the fishes, are remarkable for an air-vessel which they can fill or empty, and so rise to the surface, or sink to the bottom at their pleasure, but it differs from that of the fishes in being external; others are distinguished by a dorsal crest, which they erect and use as a sail.[5]

2. The *Echinoderms* have an opaque, leathery, or crustaceous skin, mostly covered with tubercles, or even moveable spines, and generally pierced with holes, disposed in rows; retractile tubes which respire the water, and are used also for locomotion and prehension, emerge from these holes; a mouth generally situated below, and armed with hard parts; and a cavity simple or divided.

To begin with the *Gelatines*—in walking upon the sea-shore, I have occasionally remarked an animal of this tribe left by the waves, not much larger than a nutmeg, of a spherical form, with several longitudinal ridges, and nearly as transparent as the purest crystal. If at all injured by the touch, it immediately dissolved. Such delicate creatures has the Creator exposed to the action of the oceanic waves, and they sail gaily on, by means of their ciliated tails, receiving no injury, frail as they are, except in being sometimes cast upon the shore. These lucid gems of the waters,[1] which abound equally within the polar circle and near the equator, are eminently phosphoric. Bosc says, he has seen millions, which he could scarcely distinguish during the day from the water in which they lived, but which in warm and calm nights afforded the most brilliant spectacle. From their rotatory motion, they seemed then globes of fire which rolled upon the surface of the water. The more rapid their motion, the more intense the light, and their tails always emitted more than their body. They doubtless absorb animalcules with the water that they inspire, and they swim by a motion combining rotation with contraction and dilatation. They are found from a line to six inches in diameter. Providence has destined them to be the food of a vast number of fishes, even the whale does not disdain them ; and we may conjecture the havoc that one of these giants of the ocean would make in their ranks. The manner in which they are propagated has not been ascertained, but from their infinite numbers in every sea, their progeny must be inconceivable.

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[1] *Radiaires molasses.* [2] *R. Echinodermes.* [3] *Acalepha.*
[4] *Physsophora. &c.* [5] *Vellela.*

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[1] *Beroe.*

Another phosphoric animal of the present tribe is distinguished by a dorsal crest, resembling a vesicle full of air, and which it is said to use as a sail, like many of the Molluscans, to conduct it over the surface of the waves. It is connected with the body only by its middle, its extremities being at liberty, which enables the animal to steer its course in any direction.

I shall mention one more of these gelatines, which falls under the observation of every one who is fond of sailing, or rowing, in a boat on the ocean or in its estuaries. If he cast his eye upon the water in fair weather, he will see numbers of animals, in shape resembling an expanded umbrella, with some flesh-coloured organs round the summit or centre, carried with the rising or falling tide, and dancing along with a seemingly undulating motion: these belong to what are vulgarly called the jelly-fish, or *sea-nettles*.[1] Though the body of the animals of this tribe is gelatinous and easily melts, yet its weight is considerable, and it is said that they can render themselves heavy or light at pleasure, which some effect by means of a natatory vesicle, but the means in all has not been ascertained; unless they were thus gifted, as their specific gravity exceeds that of the water, they could not raise themselves to the surface, where they are seen swimming very gracefully; as it were, by an alternate systole and diastole, admitting and rejecting the sea-water. Several of them,[1] for it is not common to them all, when touched, cause a sensation similar to that produced by the sting of a nettle:[2] it is supposed by some that this is done by their tentacles, which are conjectured to have little suckers, as indeed is very probable, which adhere to the skin. This faculty, which is supposed to be the lowest degree of the electric power peculiar to several fishes, is found in other genera of this tribe; for instance, the Jamaica sea-nettle,[3] is said to affect the hands, when touched, still more severely. Probably this faculty was given to them by Providence, either for the defence of their frail forms against their assailants, or to enable them to secure their prey, this being the general use of their numerous tentacles and other organs. Lamarck observes, that some of these animals are so large as to be more than a foot in diameter, and that some weigh as much as sixty pounds. Their multitudes are prodigious, and, as well as the *beroe*, they are said to form part of the food of the whale: they are even devoured by some of their own class. The mode by which these creatures are produced in such infinite profusion is at present unknown. They do not reproduce mutilated parts; therefore it cannot be, as in the polypes, by the division of their bodies.

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[1] PLATE III. FIG. 1.

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[1] *Rhizostoma.* Cuv. *Cephea Rhizostomæ,* Lam.

[2] See Appendix, note 22.

[3] *Physalis pelagica.*

When we consider the extreme fragility and deliquescent nature of the animals constituting this order of the Radiaries, that a touch almost disorganizes their structure, and moreover that they form part of the food of the most gigantic animals in creation, we should be led to think it impossible that they could withstand all these combined actions upon them, and that however numerous and prolific, they must at length be utterly annihilated. Nothing less, indeed, than Almighty Power, and Infinite Wisdom and prescience, and a Goodness that is interested in the welfare of the meanest as well as the mightiest of the animals he has brought into being, could have preserved them from such a fate. He who made all things decreed their mutual relations, limited their numbers by certain laws, and appointed the means by which those laws should be executed. We may say, that in some sense the whales were created for the gelatinous radiaries and numberless other animals with which the seas frequented by these monsters abound, and that these gelatinous radiaries were created for the whales. The enormous mouth of the last-named animals is not armed with tusks or grinders, but fitted instead with vast numbers of oblique laminæ of a softer substance, usually denominated whalebone, which is adapted only for the crushing and masticating of soft bodies; therefore instead of a prey more proportioned to their bulk, they contentedly make their meal off these small but innumerable gelatines, which, by their number, make up for their want of magnitude, and are exactly suited to the masticating organs of their devourer; and though the waste of animal life seems almost infinite, yet was it not for this check, so great appear to be the powers of multiplication of the smaller creatures that swarm under the ice of the Arctic seas, there would be more than could be maintained consistently with the general welfare.

The object of Providence throughout our globe, as has been before observed, is so to balance the respective numbers of the different kinds of animals, from the invisible monad to the gigantic whale, that a certain proportion may be preserved, with regard to their numbers, between them, so that each may be in sufficient force to accomplish the end for which it was created. We may observe that though the whale devours myriads of millions, yet the quantum of suffering is less than if he were enabled to make his meal off larger animals, and his jaws, like the shark's, were fitted with laniary teeth. In fact the gelatines are incapable of suffering pain, having no digested nervous system, and when cast upon the shore they dissolve into a fluid exactly resembling sea water.

The *Echinoderms*[1] form the second order of the Radiaries. This name was first given by Bruguières to a class formed solely of Linné's genera *Echinus* and *Asterias*, but Lamarck has added others to it. He has divided it into three sections, the *Stelleridans*, *Echinidans*, and *Fistulidans;* in all these the outward envelope is of a much harder substance than in the gelatines, in the first and last of these sections resembling leather, and in the other, consisting of the sea-urchins,[2] it is a crust in some degree like that of crabs and lobsters. The animals of this Order, though their nervous system is obscure, have a high degree of muscular motion and are fitted with motive organs.

To look at a *star-fish* one would wonder, at first, how it could move progressively, its rays seeming not at all calculated for that purpose, this however is wisely provided for. Those of one family send forth a number of tentacles, from a furrow in the underside of the rays into which their body is divided, each terminating in a cup-shaped sucker, which they can lengthen or shorten, and fix to hard bodies. These tentacles, or legs, as Cuvier calls them, are similar in structure in all the Echinoderms. They are separately retractile, their form is nearly that of a long ampullaceous tube, filled with a subtle fluid; the elongated tubular part is that which appears without the shell; the spherical portion remaining within the body: by means of the above fluid, as in the Polypes,[1] the tube is darted forth, or retracted. Belon counted 5000 of these suckers in one species. In the sea-urchin star-fish[2] there are twenty rays, and the suckers are so thick as to touch each other. They may probably be of use to them also as organs of prehension to seize their prey. Those of the family to which the Medusa star-fish belongs, move in a different way. The diverging rays are firm and hard, have few spines, and no channel with suckers; they are used by the animal as legs, and as they are regularly placed it can move in any direction that suits it. To go towards any particular spot, it uses the two rays that are nearest to it, and another that is most distant from it; the two first curve at their extremity so as to form two hooks, which being applied to the sand drag the body forwards, while the posterior is curved vertically, and performs the part of a repelling lever. The suckers, which in this genus issue from the sides of the rays, at the junction of the upper and lower surfaces, appear short, but being retractile, they can be lengthened, and doubtless are used to seize the animals that come in their way. What can more strikingly indicate the contrivance and design of an Intelligent Being than the structure of these stellated animals by which they are enabled to move in different directions, and to secure their prey?

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[1] *Echinodermata.*

[2] *Echinus.*

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[1] See above, p. 164.

[2] *Asterias echinites.*

The exterior envelope of the *sea-urchins* is formed by two membranes, the one external and thicker, and the other a very thin pellicle. Between the membranes is a thick, solid, calcareous shell composed of a great number of polygonal pieces of a fibrous tissue, evidently immoveable, but not soldered during the growth of the animal. The shell of the common species[1] if closely examined, when denuded of its spines and other organs, will be found to be divided into twenty longitudinal portions, ten of which are covered with breast-shaped protuberances,[2] varying in size, which bear the spines, and ten narrow ones perforated with a number of small orifices, from which the tentacular suckers emerge, which last Linné named *alleys*;[3] I shall therefore call the spine-bearing ones *groves*. These last are alternately wide and narrow, and of a lanceolate form; the wide ones having six rows of the larger tubercles, and the narrow ones only two; between each of these groves is an alley containing nearly thirty oblique double rows of orifices, eight or ten in each row. These alleys terminate in a point at the upper aperture of the shell and are truncated at the lower. Each of the larger groves, if examined internally, will be found to consist of about twenty parallelograms arranged transversely and united by an harmonic suture, in which the edges are merely applied to each other without any inequalities. These larger groves have a central longitudinal ridge, at which it readily divides and discovers a beautifully dentated suture, resembling the dog's tooth of a gothic arch;[1] on the side next the alleys the dentitions of the suture are much less prominent and conspicuous. The smaller groves have the same ridge and divide in the same way, and seem to form one piece with the alleys on each side of it: so that one of the narrow groves with its two alleys forms the support of one of the frames of the jaws.[2] These narrow groves consist of about sixty transverse pieces, and when divided of double that number: thus wonderfully is the house in which these animals reside, formed by its Divine Builder. The sutures of the human skull, as anatomists observe, admit of its more easy formation into a spherical box: the shell of the sea-urchin is adapted with equal skill and wisdom, the longitudinal sutures favoring the proper flexure one way, and the transverse ones allowing a curvature in a contrary direction: and besides, by this structure, as Mr. Gray has observed and De Blainville intimates, the gradual increment of the shell, by the deposition of fresh matter in all these parts, is rendered easy.

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[1] *Echinus edulis*. L.

[2] PLATE III. FIG. 2. *a*.

[3] *Ambulacra*. *Ibid*. *b*.

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[1] PLATE III. FIG. 3, *a*.

[2] *Ibid.* FIG. 3, *d*.

But the spines and suckers of these animals are equally worthy of our notice and investigation; the former as instruments of defence and locomotion, and the latter as instruments of locomotion, prehension, and respiration. I mentioned the protuberances, large and small, the latter usually planted round the former, shaped like a breast with a central elevation resembling the nipple, these afford a basis with which the spines articulate, being united to it by a membranous ligature or sac, so as to form a kind of ball-and-socket articulation, working upon these protuberances by means of the membrane, the spines can assume every inclination between vertical and horizontal, and may be used both as motive and defensive organs. The great zoological and physiological luminary of Greece, Aristotle, observed of these animals that they use their spines as legs for change of place,[1] and Reaumur, who paid particular attention to their motions, found, that whether they moved in a horizontal position, as they usually do, or in a reversed one, or upon their sides, they principally used their spines. As they can move in any direction, some are used as legs for progressive movement, others as points of support to prevent a retrogressive one. It is by means of their spines, also, some performing one office and some another, that they bury themselves in the moist sand on the sea shore.[2]

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[1] Hist. Anim. B. IV, c. 5, ad fin.

It is not easy to conceive by what mechanism the spines are moved; the protuberances on which they move are fixed, and there appears to be no communication between the interior of the shell and the membranous sac by which they are attached to them. "It is very difficult," says Cuvier, "to see the fibres that move these spines at the will of the animal, for nothing is observable in their articulation but a very solid ligamentous substance, which it is very difficult to cut. I have examined, with a lens of considerable power, the shell both within and without, and have been able to discover no pores on either side, round the base of the protuberances or elsewhere; so that it seems impossible for any muscular threads, however fine, to pass from the body of the animal to the connecting ligament by which it could move it and so give the spine its different inclinations.

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[1] Osler in *Philos. Tr.* 1826.

Yet as the spines are employed by the sea-urchin to effect its motions, there must be some intermediate agent, hitherto undiscovered, which it has at its command, by which it can act upon them. Dr. Carus' remarks on the zoophytes in general are very applicable in the present instance—"When we find," says he, "that there can be respiration without lungs; that nutrition, growth, and secretion may exist without a circulation of fluids; and that generation may take place without distinct sexes, &c. why should we doubt that sensitive life may exist without nerves, or motion without muscular fibres?" It is important to be observed here, that these spines, however strongly attached they may appear in the living animal, in the dead one fall off upon the slightest touch, which proves that the cause of their adhesion is connected with its life.

But though it is difficult to detect the muscular fibres that move the spines of the *common* sea-urchin, I had an opportunity, when correcting the proof containing the preceding paragraph, through the kindness of my friend Mr. Owen, of the Hunterian Museum, well known for his admirable anatomical description of the animal of the pearly Nautilus,[1] of examining a preparation of the large spines, with their sacs, of the mammillary Sea-urchin,[2] in which the muscular fibres were distinctly visible, enveloping the base of the spine, when the sac was removed; so that, reasoning from analogy, it may be concluded that the spines of the common species have a similar muscular apparatus.

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[1] *Nautilus Pompilius.*

[2] *Cidaris mamillatus.* PLATE III. FIG. 4.

The spines vary much in their form and sculpture. In the species last named they seem to be of a horny substance, varying in magnitude and length, the larger ones tapering from the base and being blunt at the tip, they are beautifully fluted like the shaft of a corinthian pillar.[1] The part enveloped by the membrane before mentioned, is thicker than the rest of the shaft, perfectly smooth, but terminates in a bead: they are tinted with violet, but the base and tip, or the pedestal and capital of the pillar are white. The base is concave so as to play upon the levigated centre of the above protuberance. Besides these larger spines, there are some bristled-shaped ones terminating in a subovate knob, which when unfolded appears to resemble a tripetalous flower with acuminated petals, and which are supposed to be polypes.[2] Those parts void of spines, called the alleys, distinguished by rows of orifices disposed in pairs, are furnished with a quite different kind of organ, I mean the suckers[3] before alluded to and described, by which the animal can also move or fix itself to any substance; it is thought also, as they are perforated, that it uses them to absorb the water for respiration. The length of these suckers or tentacles, for so they may be also called, when they are fully extended, is always greater than that of the spines, so that they may serve as so many anchors to fix the animal and enable it to resist the mass of waters that press upon it. They are stated to be more numerous near the mouth than in other parts, by which arrangement Divine Wisdom has fitted them to maintain a horizontal position, which is their natural one. These suckers fix the animal so firmly to the rocks, that it is with the greatest difficulty, and seldom without crushing the shell, that they can be separated.

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[1] *Cidaris mamillatus*, PLATE III. FIG. 14.

[2] *Pedicellariæ*, *Ibid.* FIG. 12, 13.

[3] *Ibid.* FIG. 14.

The most powerful and complex organs with which the Creator has gifted the Echinidans are their jaws and teeth. Their mouth has adapted to it a remarkable frame-work, consisting of five pieces, corresponding with five segments, into which the shell may be divided; each of these pieces forms an arch,[1] and the whole a pyramidal frame, which was compared by Aristotle to a lanthorn without a skin. To these are attached the moveable part of the apparatus, consisting of five jaws, each containing a long tooth,[2] the teeth converging in the centre close the mouth.[1] Altogether this complex machine consists of twenty-five pieces moved by thirty-five muscles. The disposition of these pieces, Lamarck observes, and of their moving muscles, indicate that the parts of this machine can have only a common movement, and no one of them an individual or separate one; but it appears from Cuvier's elaborate description of this wonderful and complex machinery, if I understand him right, that the action of certain muscles will give to any one of the teeth that form the pyramids an independent motion. This powerful apparatus, which the animal can incline in different directions, indicates a kind of food, less easy to bruise and masticate than what we have seen satisfies the whale, and these organs afford a singular contrast to those by which that enormous monster masticates its food.

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[1] PLATE III. FIG. 3. *d*.

[2] *Ibid*, FIG. 10, 11.

The Echinidans, whose station appears to be often near the shore upon submerged ledges of rock, feed upon whatever animal they can seize. We have seen that they sometimes turn upon their back and sides, as well as move horizontally, this enables them more readily to secure their food, with the aid of the numerous suckers in the vicinity of their mouth, which when once they are fixed, never let go their hold till the animal is brought within the action of their powerful jaws. Lamarck thinks they do not masticate but only lacerate their food; but as two faces of each of their pyramidal organs answer those of the two adjoining ones, and these faces are finely and transversely furrowed,[1] this looks like masticating surfaces. Bosc, who appears to have seen them take their food, says it consists principally of young shell-fish, and small crustaceous animals; as the latter are very alert in their motions, it is difficult for the sea-urchins to lay hold of them: but when once one of these animals suffers itself to be touched by one or two of the tentacles of its enemy, it is soon seized by a great number of others, and immediately carried towards the mouth, the apparatus of which developing itself, soon reduces it to a pulp.

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[1] Plate III. Fig. 9.

Who can say that the All-wise Creator did not foresee all the situations into which this animal would be thrown, so as to provide it with everything that its station and functions require? Considering its internal organization and the nature of the animal itself, and that it holds a middle station between the polype and the Molluscans, in the former of which the developement of muscle is very obscure, and in the latter very conspicuous, and that it cannot, like the former, fix itself by its base, and so support a polypary, or if endued with locomotive powers carry with it a heavy shell; these things considered, and the nature of its food, and the force necessary to prepare it for digestion, it was evidently requisite that it should be defended by a crust sufficient to afford a support, and give effect to its powerful oral apparatus, and yet light enough to yield to the efforts of its motive powers; but as this crust, from its composition and nature, was liable to be crushed by a very slight pressure, it required further means of defence, and with these its Almighty and Beneficent Creator has amply provided it, by covering it, like a hedge-hog, with innumerable spines, varying in length, and capable of various movements. The long ones, when erected, defend it on all sides, both from the attack of enemies and from the effects of accidental pressure, and we may conjecture that when the longer ones are couched to answer any particular purpose, the short ones may come into play, and assist in keeping any pressure from the crust. Perhaps, as in the hedge-hog, the ordinary posture of the longer spines is couchant, and they are only erected when the animal is in motion or under alarm.

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[1] Plate III. Fig. 11.

The wonderful apparatus which closes the mouth of the common or *typical* sea-urchin,[1] is another and striking proof that Creative Wisdom employs diversified means to attain a common end, the nutrition of the animal.

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[1] *Echinus edulis.*

The mouth of this animal is under its body, a situation far from favourable, according to appearance, for the mastication or bruising of its food: if its jaws moved vertically, like ours or the mandibles of a bird; or if they moved horizontally like those of insects, it would have been attended with no small trouble to an animal whose mouth was underneath, but its five pyramidal jaws with the points of the teeth in the centre, admit an action more accordant with the situation of the mouth. By means of its numerous muscles it can impart a variety of action to the mass and individual pieces that form its oral apparatus, so as to accommodate it to circumstances, a power not possessed by the higher animals. In those Echinidans, whose mouth is in the margin of the anterior part of the shell,[1] no such powerful apparatus is observable, its situation being in front of the animal, it is not as it were under restraint, it has less occasion for the aid either of tentacles in its vicinity, or of a powerful apparatus of masticating organs.

By furnishing these animals with a set of peculiar organs to act the part of hands as well as feet, we have another instance of the care of Divine Providence to adapt every creature to the situation and circumstances in which it is placed. The legs and arms of the higher animals would be rather an incumbrance to an Echinidan, as well as a deformity; it is therefore furnished with a set of organs better adapted to its peculiar station, wants, and functions, in a numerous set of retractile tubes[1] capable of the necessary extension, fitted at their extremity with a cup acting as a cupping-glass or sucker, and enabling the animal to adhere, with irresistible force, to any substance to which it applies them, and discharging at the same time the functions of hands to lay hold of their prey and convey it to their mouth, of legs and feet to stay themselves upon, and of lungs to assist in their respiration.

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[1] *Ananchites, Spatangus, &c.*

The workmanship also in these animal structures is as beautiful and striking as the contrivance manifested in them is wonderful. Their protuberances, especially in the mammillary sea-urchin, their variously sculptured spines, their tentacular suckers, all by their perfect finish and admirable forms declare—The hand that made us is divine—since they exceed in all these respects the most elaborate human works.

The *third* and last section of the Echinoderms, or spiny-skinned Radiaries, are the *Fistulidans.*[2] Amongst these we may notice the *Sea-anemonies,*[3] marine animals, fixing themselves to the rocks, but having the power of locomotion, which from a common base send forth what appear to be a number of stalks terminating each in what seems a many-petaled flower of various hues, so that those who have an opportunity of observing them from a diving bell, may see the submerged rocks covered with beautiful blossoms of various colours, and vying with the parterres of the gayest gardens. Ellis, who was the first Englishman who opened his eyes to the beauties and singularities that adorn the garden which God has planted in the bosom of the ocean, has named many of these from flowers they seem to represent, as the daisy, the cereus, the pink, the aster, the sunflower, &c.

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[1] Plate III. Fig. 5.

[2] *Fistulides,* Lam.

[3] *Actinia.*

These animals, at first, appear to come very near the polypes, especially the fresh-water ones,[1] bearing a number of individuals, springing, as it were, from the same root, each sending forth from its mouth a number of tentacles, which are stated to terminate in a sucker, and by which also, like the other Echinoderms, they respire and reject the water; they also reproduce their tentacles when cut off. Portions of the base when divided are reproductive, but they do not separate from the parent till their tentacles are completely formed. Their internal organization, however, is much more advanced than that of the polypes. They have a separate alimentary sac or tube, surrounded by longitudinal muscles, and even nervous nodules or ganglions, and also several ovaries.

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[1] *Hydra.*

In mild calm weather, when the sun shines, they may be seen in places, where the water is not very deep, expanding their many-coloured flowers at the surface of the waters—but upon the slightest indication of danger, the flowers suddenly disappear, the animal contracts itself and wears the aspect of a mass of flesh. They as it were, vomit up their young, or the germes formed in the ovaries: but they sometimes force their way out from other parts. When inclined to change their station they glide upon their base, or completely detaching themselves, commit themselves to the guidance of the waves. Reaumur observed them use their tentacles like the Cephalopods, for locomotion. They fix themselves with so much force, that they cannot be detached without crushing them.

It is not wonderful that so many of the lower aquatic animals should have been mistaken for plants, when they so exactly represent their forms, their roots, their branches and twigs, their leaves and their flowers—but besides the irritability of the animal substance, which however is partially exhibited by some plants; there is another character which seems, as a strong line of demarcation, to be drawn between them, and to which I have before adverted;[1]

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[1] See above, p. 139.

animals take their food by a mouth at one extremity of the body, plants by roots diverging from the other. The reproductive organs in the latter occupy the place and ornature of the nutritive ones in the former. The gay and varied colours of the blossoms, the infinite diversity of their forms, the delicious scent so many of them exhale, all are calculated to draw the attention and excite the admiration of the beholder, while the organs of nutrition are usually hid in the earth. Not so in the animal kingdom; the nutritive organs, or rather those that prepare the nutriment, are placed in the most eminent and conspicuous part of the body, in the vicinity of all the noblest avenues of the senses, while those of reproduction are placed in the most ignoble station, and are usually found closely united with those passages by which the excretions of the body pass off. In the *Tunicaries* indeed the mouth and the anal passage[1] are usually very near to each other, and in the polypes the same mouth that receives the food rejects the feces, and it even sometimes appears to happen than an animal has been swallowed, and after performing the ordinary revolution in the stomach, has been ejected again in a living state.

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[1] PLATE IV. FIG. 1.

CHAPTER VII.

Functions and Instincts. Tunicaries.

THE animals we have hitherto been considering were all regarded by Cuvier as belonging to his first class, the *Zoophytes*, and are continued therein by Carus; the latter, however, allows that the *Echinoderms* are somewhat removed from the class by the commencement of a nervous system. Lamarck's next Class, the *Tunicaries*,[1] which we are now to enter upon, form part of the headless Molluscans[2] of Cuvier, and belong to that section of them that have no shells. My learned friend, Savigny, in his elaborate and admirable work on *The Invertebrate Animals*, who also considers them as a separate class, denominates them *Ascidians*,[3] dividing them into two Orders, *Tethydans* and *Thalidans*.[4] Many alcyons of Linné and others, are now referred to the Class we are treating of.

The characters of the class may be thus stated: ANIMAL, either gelatinous or leathery, covered by a double *tunic*, or envelope. The external one, analogous to the shell of Molluscans, distinctly organized, provided with two apertures, the one *oral*, for respiration and nutrition, the other *anal;* the interior envelope, analogous to their mantle, provided also with two apertures adhering to those of the outer one. *Body* oblong, irregular, divided interiorly into many cavities, without a head; *gills* occupying, entirely or in part, the surface of a cavity within the mantle; *mouth* placed towards the bottom of the respiratory cavity between the gills; *alimentary tube*, open at both ends; a *ganglion*, sending nerves to the mouth and anus.

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[1] *Tunicata.*

[2] *Mollusca Acephala.*

[3] *Ascidiæ.*

[4] *Tethydes, Thalides.*

These animals are either simple or aggregate; fixed or floating: the simple ones are sometimes sessile,[1] and sometimes sit upon a footstalk.[2] The aggregate ones possess many characters in common with the polypes, inhabiting, as it were, a common body, somewhat analogous to the polypary, except that it is more intimately connected with the animal that inhabits it: the *mouth* of all is surrounded with rays or tentacles, as is also, in many, the anal orifice; but in their organization they differ very widely, exhibiting traces of a nervous system, and even, in some, of one of circulation. The fixed ones are commonly attached to rocks or other inorganized substances, but sometimes they are parasitic; thus a species of botrylle[3] envelopes, like a cloak, certain ascidians, and another of the Tunicaries[1] envelopes the madrepores, more or less, with a milk-white crust.

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[1] *Cynthia.* [2] *Clavelina.* [3] *Botryllus polycyclus.*

The Creator, when he filled the waters of the great deep with that infinite variety of animals of which every day brings genera and species, before unknown, to light, willed that many of them should, as it were, form a body politic, consisting of many individuals, separate and distinct as inhabiting different cells, but still possessing a body in common, and many of them receiving benefit from the systole and diastole of a common organ: thus, by a material union, is symbolized, what in terrestrial animal communities results from numerous wills uniting to effect a common object. The land, as far as I can recollect, exhibits no instance of an aggregate animal; nor the ocean of one, which, like the beaver, lemming, bee, wasp, ant, white ant, and many others, forms associations to build and inhabit a common house, and rear a common family. —Probably the nature of the different mediums these several animals inhabit is the cause of this diversity; and Providence, when it willed the peopling of the waters, as well as of the earth and air, into which the effluxes of light and heat from the central orb could not so penetrate and be diffused as to act with the same power and energy as upon the earth's surface, and in its atmosphere, so formed them as to suit the circumstances in which they were to be placed. Instead of sending the social aquatic animals forth by myriads to collect food and materials for their several buildings, he took the vegetable creation for the type of their general structure, in many cases fixed them to the rock or stone, united them all into one body, which, under a common envelope, contained often innumerable cells from which were sent forth by the occupant of each a circle of organs to collect food, from which, by some chemical operation, they could elaborate materials for the enlargement of their common house ; and often cause that influx and reflux, to compare small things with great, resembling the oceanic tides, and by which the sea-water is alternately absorbed and rejected by these animals : but this function, in the case of some of the Tunicaries, the animals with which we are now concerned, seems to be affected by a central organ or pump common to the whole fraternity.

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[1] *Didemnum candidum*, Sav.

But although none of the marine associated animals are employed, like the terrestrial ones, in labours that require locomotion and the collection, from different and often distant parts, of materials for the erection of their several fabrics, and of food to store up for the maintenance of the various members of their community, yet there are some that are instructed to form associations, which yet are not united by any material tie or common body, so as to be *physically* inseparable. Of this description are the *Salpes*,[1] or biphores, as the French call them. These are phosphoric animals, so transparent that all their internal organs and all their movements, and even all the contents of their intestines, may be distinctly seen. They are gelatinous like the medusas and beroes, and like them dissolve into water. Their organization, however, proves them to be *Tunicaries.* Certain species of these animals, in this respect unlike every other genus of the animal kingdom, have the property of uniting themselves together, not fortuitously and irregularly, but from their birth and in a certain undeviating order. Bosc observed the reunion of the *confederate Salpe*,[2] which he thus describes: "Every individual is attached by its sides to two others, the mouth of which is turned to the same side; and by the back also to two others, when it is turned to the opposite side." In this circumstance it presents an analogy to the combs of the hive bee, in which each comb consists of a double set of cells placed base to base, with the mouths of each set looking opposite ways, and the cells so placed that a third of the base of three cells occupies the whole of one base in the opposite set.[1] This reunion, in the salpes, is effected by means of eight pedicles, of a nature exactly similar to that of the body. It is perfectly regular, that is to say—all the individuals are at the same distance and height, all the heads in one row are turned to the same side, and those of another to the opposite. These rows usually consist of from forty to fifty individuals, and are carried by the waves sometimes in a straight, sometimes in a curved, and sometimes in a spiral line. In the sea, during the day, they appear like white ribands, and during the night like ribands of fire, which alternately roll up and unroll, wholly or partially, either from the motion of the water, or from the will of the animals that compose them. They are found in the ocean only at a great distance from land. Professor Eschscholz mentions one,[2] intermediate between the *Salpes* and *Pyrosomes*—and a similar one is now in the Hunterian Museum[3]—which by means of a pedicle appeared to be attached to some *common* body, all of them arranged in rows with the head turned to the same side; Savigny, whose eye nothing escaped, and the acumen of whose intellect equalled that of his sight, alas now dark, further informs us, that the Salpes adhere to each other only by certain gelatinous protuberances, or as Lamarck suspects, certain lateral suckers, disposed so as not to impede the motions of the muscles; but their union is only temporary. At a certain age, M. Peron observes, these animals separate, all the large individuals being solitary. The same traveller is of opinion that the concatenation of the Salpes is coeval with their birth.

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[1] *Salpa.*

[2] *Salpa confœderata.*

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[1] Plate XI. Fig. 3.

[2] *Anchinia.*

[3] Plate IV. Fig. 2.

The object of Divine Providence in endowing these animals with an instinct so singular can only be conjectured. They are of so very frail a nature, that perhaps when first produced, the fluctuations of the mass of waters, to the surface of which they appear to rise, might be sufficient to destroy them, or to carry them to the shore, where they would inevitably perish; but by being united in bands, they may be better able to resist their force, and perhaps the more vivid light they thus produce, may be designed for defence,[1] or to answer some other important purpose. When they have attained maturity of size and strength they may be better able to direct their course and avoid these injuries. The young of terrestrial animals generally are associated, under the guidance and protection indeed of the mother, till they are of age to take care of themselves. The object of Providence in both cases is the same, though the modes of its accomplishment vary according to the situation and circumstances of individuals. When we see such paternal care manifested for the welfare and maintenance in existence, of beings so frail, that a mere touch would dissipate them, we cannot but assent to the observation of the Psalmist, that "*His tender mercies are over all his works*," the least and most insignificant as well as those that appear to occupy the most elevated place in the animal kingdom: and we may feel a comfortable assurance, built on this ground, that the eye which regards even these seemingly insignificant creatures, will, if we cast not off our confidence, never overlook *us*, or be indifferent to *our* welfare.

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[1] See above, p 178.

The last and highest tribe, belonging to the present class, are those which are never united to each other, but are solitary in all stages of their existence. These, as well as the preceding ones, make a near approach to the real Molluscans, at least their external and internal envelope bears considerable analogy with that of bivalve shells, as Lamarck acknowledges, though they differ in having a distinct organization, the shells of bivalves having neither apparent vessels nor fluids, while, in these Tunicaries, the covering, both external and internal, in some species, exhibits vascular ramifications very conspicuously.

Though several of the animals belonging to the class of Tunicaries are interesting on account of their singularity and beauty, I shall only select two, one from the aggregated, and one from those that are simple, for description and further remarks, and then proceed to the great class of Molluscans. Who would think, asks Lamarck, that the *Pyrosome*, first observed by Peron and Le Sueur, was an assemblage of little aggregate animals; any one that looked at this animal, or at Savigny's figure of it,[1] would mistake it for a simple polype, with a number of leaf-like appendages growing from its skin: but a closer examination would give him a very different idea, and he would discover, with wonder, that it was a mass filled with animals, united by their base, exceeding the number of the above appendages. The common body that contains these creatures resembles a hollow cylinder closed at its upper extremity and open at the lower; this body or mass is gelatinous and transparent, a number of tubercles of a firmer substance than the tube, but at the same time transparent, polished, and shining, differing in size, cover the surface; some being very short, and others longer, and the longer ones terminated by a lance-shaped leaflet. At the summit of each tubercle is a circular aperture, without tentacles, opposite to which is another circular orifice which is toothed.

The pyrosomes are the largest of the phosphoric animals, the *Atlantic* species[1] being about five inches long, and the *Mediterranean*[2] sometimes attaining to the length of fourteen. Their power of emitting light is so great that in the night they cause the sea to appear on fire. Nothing can exceed the dazzling light and brilliant colours that these floating bodies exhibit—colours varying in a way truly admirable, passing rapidly every instant, from a dazzling red to saffron, to orange, to green, and azure, and thus reflecting every ray into which the prism divides the light, or which is exhibited by the heavenly bow. In the water their position is generally horizontal, and their locomotion very simple: they float, as they are carried by the waves or the currents; like the salpes, they can however contract and restore themselves individually, and have also a very slight general movement which causes the water to enter their common cavity, visit their gills for respiration, and convey to them the substances which constitute their food. M. Le Sueur observed that when the central cavity of the common tube was filled with water, it was immediately spirted forth in little jets from all the extremities of the tubercles with which the surface was covered, from whence it appears that the external aperture of the individual animal is really the anal aperture, and the opposite or internal one the mouth, which thus received the water and the food it conveyed from the common tube, and rejected it by the orifice of the tubercles.

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[1] *Anim. sans. Vertèbr.* Pl. IV. Fig. 7.

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[1] *P. atlantieum.*

[2] *P. giganteum.* PL. IV. FIG. 3.

The internal organization of the little tenants of the common tube is given with considerable detail by Savigny,[1] the general opening at the summit, or truncated end of the tube, has an annular diaphragm, from which it appears that they are arranged in circles round it, so that in this respect they form rays; in shape they somewhat resemble a florence-flask, and have alternately a long and short neck. The cavity below the neck is filled by the gills and various intestines, which it would be difficult to describe intelligibly, in a popular manner. There seems some analogy in these floating hives of luminous animals, both as to size and motion, with the sea-pens.[2]

No species of the genus appears to have been met with in our seas, we may therefore conjecture that a warmer climate is essential to them. Their general functions beyond that of illuminating the great theatre in which their Creator has placed them, and probably affording food to some of the inhabitants of the seas in which they are found, have not yet been ascertained. Neither of the orifices of these little animals is furnished with tentacles, but their branchial orifice is toothed, in this they appear to differ from the great majority of aggregate animals. We may conjecture that when the water passes into the tube the diaphragm is either dropped or elevated to admit it, and then resuming a horizontal position closes the orifice so that the water is forced into the interior aperture of the individual animals and passes out, as above described, by the exterior one. Food-collecting tentacles, therefore, would in this case be unnecessary, as their food would enter their mouths with the water. Providence thus taking care to compensate by this contrivance for the want of the ordinary instruments.

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[1] *Ubi. supr.* pl. xxii. xxiii.

[2] See above, p. 178.

Some of the Tunicaries are stated to have recourse to a singular mode of defence. When seized by the hand, contracting themselves forcibly, they ejaculate the water contained in their cavities, so as often suddenly to inundate the face of the fisherman, who in the astonishment of the moment suffers the animal to escape. If this be a correct statement it proves that these animals are not altogether without some degree of intelligence, they know when they are assailed and how to repel the assailant.

Having given some account of the most interesting of the *aggregate* Tunicaries, I am next to notice the *simple* ones.—In these the two orifices by which the sea water is received and expelled are not at opposite extremities, but usually approximated, one being higher than the other and furnished with tentacular filaments. The animals are fixed to rocks, shells, and sometimes to sea-weeds, and are either sessile, or elevated on a footstalk: the sessile ones present a considerable analogy with the puff-balls, and the others with different funguses, as *Clavaria*, &c. They seem, especially *Boltenia*, which is covered with short stiff bristles, to approach the *Echinidans*. Nothing more is known of these animals, than that, like the others, they alternately absorb and expel the sea water. The *Cynthia Momus*[1] is remarkable for its changes of colour, being sometimes white, sometimes orange, and sometimes of a flesh-colour. As all this tribe are fixed, their history furnishes no other interesting traits.

Nothing is more striking than the infinitely diversified forms into which Creative Power has moulded the little frail animals, in this as well as the preceding classes, that are destined to inhabit, and numbers of them to illuminate, the wide expanse of waters occupying so large a portion of the globe we inhabit. When we survey, with curious and delighted eyes, the varied tribes that cover the soils of every aspect and elevation of that part of it that emerges from the fluctuating surface of the great deep, and which, instead of deriving their nutriment and means of life and breath from the waters, saline or fresh, live, and breathe, and are fed, by principles and elements communicated, either mediately or immediately, from the atmospheric ocean, an expanse that envelopes uninterruptedly the whole of our globe, and which itself is fed and renovated by the constant effluxes of the great centre of irradiation; which also in its turn, as well as all the other orbs that burn and are radiant, and those that revolve around them and reflect their light, receive their all from *Him*, that GREAT AND INEFFABLE BEING, who gives to all and receives from none. But I lose myself, in infinite amazement; I shrink into very nothingness, when I reflect that such a miserable worm as I am, so fallen and corrupted, should presume to lift its thought so high, and lose itself in the depths of the unfathomable ocean of Deity. He has, however, commanded us to seek him, and assured us we shall find him if we seek him humbly and sincerely—he hath set before us his *works* and his *word*, in both of which he has revealed himself to us: and if our great object be to glorify him rather than ourselves, we shall collect the TRUTH from each, and shall find that they deliver, though each in a different language and style, the same mysteries; for they are the work and the word of the same Almighty Author, and must, therefore, if rightly interpreted, deliver the same truths, since they can no more contradict each other than he can contradict himself.

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[1] Plate IV. Fig. 1.

But let me endeavour to emerge from this ocean in which I seem to have lost myself, and, recovering my station upon *terra firma*, direct the attention of the reader to the lovely tribes that adorn every part and portion of this our destined but brief abode, I mean to the vegetable kingdom; we see how they cover earth, that not a spot can be found, of which in time they do not possess themselves, and that the more we extend our inquiries the more numerous are the individual species with which we become acquainted. This being the case upon earth, reasoning from analogy, we may conclude that something similar takes place in the ocean; that could our discoveries be extended under the sea as easily as they are upon land; could we traverse the bed and waters of the great deep with the same facility that we do the surface of the earth, we should find the numbers of vegetables that respire, in some sense, the air, fall short perhaps of those plant-like animals that respire the water. And could we examine the individual species of which this infinite host consists, and compare their organizations, we should find as great a difference in the instruments and organs by which their life is supported and their kind continued, as in the animals themselves; and yet in all this diversity should trace a harmony and concatenation that would evidently prove the Wisdom that contrived, the Power that formed, and the Goodness that gave a living principle and breath of life to all these creatures, were each of them the attributes of an INFINITE BEING.

CHAPTER VIII.

Functions and Instincts. Bivalve Molluscans.

HITHERTO in our progress from the lowest animals upwards, the mind has been perpetually submerged; not only every group, but every individual that we have had occasion to consider, has been an inhabitant of the waters, and to the great body of which a fluid medium is as necessary to life and action as an aërial one is to a land animal, but now we shall be permitted to emerge occasionally, for although the largest proportion of the animals forming the great class we are now to advert to, the *Molluscans*, are also aquatic, yet still a very considerable number of them are terrestrial, as a stroll abroad will soon convince us, when after a shower we find we can scarcely set a step without crushing a snail or a slug.

The term *Molluscan*[1] was employed by Linné to designate his second class of worms,[2] which excluded all the shell-fish, and amongst real Molluscans included both Radiaries, Tunicaries, and Worms; it literally signifies a nut or walnut, and therefore seems more properly applied to shell-fish, than to animals which are defined as simple and naked. As now understood, it still comprehends a very wide range of animal forms, and it seems difficult to describe them by any character common to them all. Their Almighty Author, in the progress of his work of creation, linked form to form in various ways; he not only made an animal of a lower grade a stepping-stone towards one of a higher, and which formed a part of the ascent to man, the highest of all; but as the mighty work proceeded, he threw out on each side collateral forms that ascend by a different route, or begin one to a different order of beings. And this circumstance it is that has opened the door for so many systems and that diversity of sentiment with respect to the grouping of animals, which we meet with in the writings of the most eminent naturalists. Some proceed by one path and some by another, though the object of all is the same, unless some bias from a favourite hypothesis interferes and diverts them from a right judgment.

The organization of the animals of the Class we have just left, as we have seen, appears of a higher character than that of any of the preceding ones; traces of a heart appear; a nervous ganglion is detected between the mouth and anus, sending nerves to each; a regular respiratory system by means of gills becomes evident; but still the animal is furnished with no head, no eyes, and in numerous cases has no separate existence, but forms a branch of the general body—thus resembling a plant—from which it cannot dissociate itself and become an independent individual.

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[1] *Mollusca.* [2] *Vermes.*

Indeed when we enter the Class of Molluscans, we find that the nearest affinities of the Tunicaries have likewise no head, and this circumstance appears to have induced Lamarck not only to separate them from the class as arranged by Cuvier, but also his whole family of headless Molluscans,[1] of which he forms his two Classes of *Cirripedes*[2] and *Conchifers*.[3] The absence of a head from the animals of the bivalve and multivalve shells, is certainly a circumstance which, at the first blush, appears to justify their separation *classically* from the other Molluscans, but when we compare other characters, we shall find many that are common to both, particularly their nervous system, which is the same both in the Conchifers and Molluscans of Lamarck; for neither of these exhibit a medullary ganglionic chord, but only dispersed ganglions which send forth the requisite nerves; both have a double or bilobed mantle, gills on each side, and a heart and circulation. The *Cirripedes* indeed seem to be of a higher grade, at least their nervous system is more perfect—since they have a longitudinal spinal marrow with ganglions, a mouth furnished with toothed jaws disposed by pairs, and *jointed* tendril-like organs about the mouth—and approaches near to that of the Annulose animals,[1] the *Condylopes* of Latreille. These, therefore, may be considered as properly entitled to the denomination of a Class; but should not be placed at a distance from the Crustaceans, to which Lamarck, with reason, thinks they make a near approach, as they are by Cuvier and Carus. In fact, they seem to have little to do with the bivalve Molluscans, except in being defended by more than one shell, and having no head.

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[1] *Mollusca acephala.*

[2] *Cirripeda.*

[3] *Conchifera.*

I shall now mention the most prominent characters of those shell-fish, that I regard as strictly entitled to the denomination of *Molluscans*.

Animal soft, without articulations. *Mantle* bilobed, enveloping more or less the animal. *Gills* varying. A *heart* and circulation. No *medullary chord* with *ganglions*, but a few scattered ganglions from which issue *nerves* to various parts. *Body* commonly defended by a calcareous *shell*, to which it adheres only by one or two points, but in some instances it is externally naked, and has an internal bone.

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[1] *Annulosa.*

The Molluscans may be divided into several families, and those of Cuvier are mostly natural, but as my plan has been to ascend from the lowest grade of animals towards the highest, I shall reverse this order, and begin my observations with the last of his families, or more properly speaking *Orders*, excluding for the present the *Cirripedes* of Lamarck, or most of the multivalves of Linné, as leading off laterally towards the Crustaceans.

His first order he calls *Acephales*, or headless Molluscans, it includes all the bivalve shells of Linné, with the addition of the Pholads or stone-borers.[1] Lamarck has divided it into two sections, which, regarding it as a Class, are with him *Orders;* the first is *Bimuscular*,[2] having *two* attaching muscles, and *two* muscular impressions; and the second is *Unimuscular*,[3] having only *one* such muscle with *one* impression. With regard to their habits and economy, the bivalve Molluscans may also be divided into *two* sections, the *first* of which may consist of those that inclose themselves either in a cell or burrow, or live in the mud, &c.; and the *second* of those that fix themselves to the rocks, stones, and other substances, by means of a *Byssus*, which they have the faculty of spinning from their foot or other part, or by a *tendinous ligament* which they protrude through an orifice in their shell.

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[1] *Pholas.*

[2] *Conchifères dimyaires.*

[3] *C. monomyaires.*

The general habit of the *first* family, including a vast variety of forms, seems to be that of *boring* and *burrowing*, many piercing wood, and even rock, and others burrowing in the sand, sometimes to a great depth. Thus they are instructed by their instinct to form a convenient cell or other habitation, either constantly submerged, or only when the tide visits them, in which they are enabled to procure their destined food, of what nature does not appear to have been clearly ascertained, although probably animalcules, introduced when they inspire the water for respiration, may form a principal portion of it, as the majority having no teeth for mastication, require a kind of nutriment for which it is not necessary: comparing this tribe of aquatic animals with those of the antecedent classes, we see the same object effected by different means. The *sheathed* polype[1] builds a house of matter elaborated in its own stomach, while the ship-borer[2] pierces wood, and the stone-borer the rocks, and the razor-shell[3] burrows deep in the sand with the same view;

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[1] See above, p. 166. n. 2.

[2] *Teredo.*

[3] *Solen.*

and thus each is instructed by its Omniscient Creator, and fitted by its structure and organization, to accomplish the intended purpose, but by different means and instruments.

While each of these creatures has a particular and individual end in view, in its several proceedings, its own accommodation and appropriate nutriment and defence; the Creator, who has gifted them accordingly, makes use of them as instruments, which by their combined agency, though each, as it were, by a different process, accomplish, usually by slow degrees, His general purposes. This object, in the present instance, as well as in numerous others, seems to be to remove obstacles that stand in the way, and prevent certain changes willed by Providence, in the sea-line of any country, from taking place. Rocks may be regarded as so many munitions of a coast, which prevent the encroachment of the ocean, but nothing can more effectually prepare the way for the removal of this safeguard, than its being, as it were, honey-combed by numberless stone-borers, that make it their habitation, thus it must be gradually rendered weaker; till it is no longer able to resist the impetus of the waves; the process is very slow, but it is sure; and it is worthy of remark, by what a seemingly weak organ most of these animals are enabled to effect this purpose, a fleshy foot, strengthened by no internal bone or gristle, but upon which they can turn as upon a pivot, and so in due time effect their destined purpose.

I shall now proceed to furnish some examples of the manner in which this is effected: and give an account of some of each of these tribes, beginning with those, and they are numerous, that make the burrows in the *sand* to a considerable depth, so that it presents a less solid mass to the action of the waves.

I shall first call the reader's attention to the proceeding of one usually denominated the *razor-shell*, from the supposed resemblance of some of the species to that instrument; in substance and colour they are often like the human nail, and as they, as well as the stone-borers, are stated to emit a phosphoric light, and also are eaten, it seems to me most probable that they are the animals and not the pholad as is usually supposed, which the Roman naturalist describes under the name *Dactyle*.[1] These animals burrow in the sand, sometimes to the depth of two or three feet, and never quit the burrow unless by force. Poli says the collectors of them are accustomed to pour oil upon the water, which renders it quite transparent so that they can discern the razor-fish in its burrow by its tubes which are exerted. So powerful are its struggles, that, though they wind linen about their feet, they are often severely wounded by the sharp edges of their shells. The animal descends to the bottom of its burrow when the tide retires, and there remains till its return when it rises again. In order to take it, the fishermen are accustomed to cast into its retreat—which always remains open for respiration, and which is indicated by a little jet of water—a very little salt, this probably deceives the razor-fish and causes it to ascend, thinking the tide returned. They bury themselves with wonderful celerity by the rapid action of their foot, and mount again by the combined action of that part and their smooth valves. The former is cylindrical and ends in a spherical summit of larger diameter than the rest of the foot.[1]

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[1] See Appendix, note 23.

The *common cockle*[2] is also a borer. Mr. Osler, in a very interesting paper in the ***Philosophical Transactions*** for 1826, has described the way in which they bury themselves. The foot of the cockle, he observes, is very strong and stiff, and is the instrument by which they principally perform this operation; but to look at it when unemployed, we cannot readily conceive how it can make a burrow capacious enough for so large a shell. Its point, indeed, is solid, and a viscid secretion from its surface enables it to fix itself more firmly in the sand, but this alone is not sufficient to accomplish this purpose, it is therefore further gifted with the power of distending it to a size, nearly equalling that of its shell—but how is this effected? It has a tube, opening just within the mouth, which conveys to the foot the water by which the animal is enabled to distend it—thus the size of the boring auger becomes so nearly equal to that of the shells, that the solid point or bit first entering the sand, in time, by rotatory motions often repeated, works a burrow that receives the shell, and the animal is buried with only the extremity of its siphon emerging. How admirable is this contrivance of Divine Wisdom to enable it to bury its shell, which it could scarcely otherwise accomplish.

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[1] Plate V. Fig. 1.

[2] *Cardium edule.*

We easily comprehend the use of terrestrial burrowing animals, by this habit they not only construct a habitation for themselves, but by the mould they throw out they help to fertilize and renew the soil; but with regard to the aquatic burrowers on the barren sands, which the tides submerge, we only see one end answered, the welfare of the individual who forms them: but they likewise doubtless answer some more general purpose connected with a plan of Providence which daily advances towards its completion, though we do not clearly comprehend what that end is. I was once conversing with a fisherman of a village on the N. E. coast of Norfolk on the subject of his trade, when amongst other matters he observed, that from some alteration in the sands of that coast the number of small shell fish had considerably diminished of late years, which being the principal food of soles and other flat fish had occasioned a great diminution of them also. An over abundance of burrowing bivalves may undermine the beach to that degree, that the sea in high tides and stormy weather may make such a breach upon it as may carry away, or bury too deep, a large proportion of these shell fish, which would cause the fishes to leave the coast for one better provided with food for them.

No animal has been more celebrated for the mischief it has occasioned as a *timber-borer* than that of which I shall next give some account. I am speaking of the *ship-worm*.[1] Though the animal of some of the land-shells, as the snails,[2] do him some injury in his garden, man seldom suffers very materially from their ravages, but the ship-worm, where it gets head, does him incalculable injury: destroying piles as far as they are under the water and every thing constructed of timber that is placed within their reach, to which they are as injurious as the boring wood-louse;[3] they even attack the stoutest vessels, and render them unfit for service. Their object however is not to devour the timber, but with the same view that the pholads bore into the rock, to make for themselves a cell in which they may be safe from their enemies; their food is probably conveyed to them in the sea water. These animals cannot exist in fresh water, they pierce the wood by means of what Carus calls boring shells moved by a double-bellied muscle. The valves of the shells of this animal are emarginate or bilobed, both lobes are beautifully scored at the margin, but in different directions, the furrows in one being much the finest and receiving those of the other. The mode in which these animals bore has not been ascertained, probably it is by the rotation of their valves. Sir E. Home describes them as protruding a kind of proboscis which has a vermicular motion, and which he supposes to act as a centre-bit while the creature is boring. The shells, by means of their ridges, probably act, like those of the pholads, as rasps. They bore in the direction of the grain of the timber, deviating only to avoid the track of others.

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[1] *Teredo navalis.* [2] *Helix.* [3] *Limnoria terebrans.*

Various are the animals whose function it is to attack substances from which the vital principle is departed, nor are those, we see in the foregoing instance, which are submerged, always exempted from this law. Fortunately the aquatic animals, that prey upon timber, fall very far short of the terrestrial ones in their number and in the amount of the damage they occasion, and their aversion to fresh water is the safeguard of our bridges and other buildings that are erected upon piles—did an animal, with the boring powers of the ship-worm, enter our rivers and abound there, we should see the magnificent bridges that so much adorn our metropolis and are so indispensable to its inhabitants, gradually go to ruin—the vast stones with which they are built might become the habitation of pholads, and other rock-borers, and the communication between the two sides of the river greatly interrupted. But a merciful Providence has so limited the instincts of the different animals it has created, that they cannot overstep a certain boundary, nor extend their ravages beyond the territory assigned to them. The law laid down to the ship-worm is to hasten the decay of timber, that is out of its place, and may be denominated an unsightly encroachment upon the ocean—this is the law they must obey, and they make no distinction, whether it is disowned by all, or an important and valuable part of man's property. Their individual *object*, as has been stated above, is their own benefit, and they neither know that they obey a law of God, or injure man, but the Almighty by an irresistible agency impels them to it, and they fulfil the purposes of his Providence, at the same time that they provide for their own welfare.

The history of none of the boring bivalves is more interesting than that of the *Pholads*, or stone-borers. These animals are defended by two very fragile shells strengthened indeed by supplementary pieces, and rough like a file, inhabited by a very soft animal which appears to be furnished with no organs adapted to boring so hard a substance as a rock. When the young are disclosed from the egg, being cast upon the rock in which their mother resides, they bore a hole in it which they enlarge daily, and which they never leave, unless compelled by force. This hole always communicates with the water, and is the orifice through which the animal exerts its double siphons; one of these siphons is its mouth and the other its anal orifice. Reaumur made some observations upon their mode of boring, he says, that it is by the rotation of the two valves of their shell which form a rasp, and continually wear away the rock which surrounds them. The surface of the valves of the shell is ridged longitudinally and transversely, and rough with asperities at the intersections of the ridges which seems to fit it for such an office, but still it is usually so tender and friable, that one would not expect it could act upon a rock, nor could it be by this agency that they first make an entry when young, or bore through shells, madrepores, and wood as they are said to do. They are stated principally to select calcareous rocks and sometimes hardened clay, which seem better adapted to the nature of their shells. Poli says they use their foot as an auger in excavating their crypts, the shell revolving upon it as upon an axis.

Mr. Osler, in the memoir before alluded to, states that the pholads can be observed to burrow only in the young state: and that they are found completely buried when so minute as to be almost invisible. The guiding hand of Providence excites them from their very birth to fix themselves by their pointed foot, to erect their shells, and giving them a partial rotatory motion which employs the valves alternately, thus to enlarge their habitation, and this almost constantly, since the rapidity of their growth, for the first few weeks, compels them to act perseveringly in effecting that object, for the raspings of its crypt would clog the animal if they were left in it. When the siphon is distended with water, the animal, closing the orifices of its tubes, suddenly retracts them: thus a jet of water is produced which is prolonged by the gradual shutting of the valves, and clears the shell and the crypt.

There is another family of bivalves which bores the rocks, the species of which are instructed by their Maker, to accomplish their object by a very different process. I allude to Lamarck's family of *Stone-eaters*.[1] This family contains only two genera, removed from *Venus*, which he denominates *Saxicave*,[1] and *Petricole*,[2] the habits of which appear to be the same. M. Fleurian-de-Bellevue has described the proceedings of a species found in great numbers in submarine calcareous rocks near Rochelle. It lives like the pholads in crypts within the rock, but as the crypt is not circular, it is clear it cannot be produced by a revolution of the animal upon its foot; M. de Bellevue, therefore, concluded that it dissolved the stone by means of a phosphoric acid transuding from its body. Some have thought, that did the animal secrete such an acid, it must have destroyed its shell, but since the rock round the crypt is found to be differently coloured from the rest, for a little thickness, and the animal does not frequent the argillaceous, basaltic, and other rocks in the vicinity, but only the calcareous ones, M. Bellevue's opinion is rendered not improbable. It is surely very possible that the acid may be so mixed and tempered as to act upon the rock and not upon the shell. Mr. Osler, in the memoir lately quoted, brings forward some very powerful additional arguments which confirm this opinion. The species which he observed was the rugose saxicave.[3] This animal fixes itself by a byssus from the foot, and therefore cannot perform a rotatory motion, and it appears to have no mechanical means of excavating its crypt—it can act solely upon the calcareous part of the rocks it perforates—for these and other reasons, Mr. Osler is of the same opinion with M. de Bellevue.

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[1] *Les Lithophages*.

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[1] *Saxicava.* [2] *Petricola* [3] *Saxicava rugosa.*

Poli has described a stone-boring bivalve, belonging to the *muscle* genus, which perforates marble, each inhabiting a separate crypt, generally as large as the shell, and which he thinks they enlarge by friction and rotatory motion. The pillars of the temple of Serapis at Puteoli were perforated by these animals at the height of forty-six feet above the sea, whence it is probable they were so perforated before they were carried there.[1]

When we compare the proceedings of these four kinds of boring or burrowing Molluscans, above described, with their forms, we shall find in them a particular adaptation of means to an end. In the ship-worm, whose province is to penetrate into submerged timber and there to take its abode, we find the anterior part of the body armed with two shelly valves, moved by strong muscles, which cut and rasp the substance upon which they act, so that it probably begins its labour as soon as it is born, introducing its narrow body, defended at the other extremity also by shell, into the timber softened by the water, and slowly increasing its crypt as its dimensions increase—in this case the most powerful action seems to be at the anterior end, though assisted, it may be, by some motion at the posterior. This kind of action appears best suited to its slender body.

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[1] Poli, ii. 215.

Let us next examine the pholads, all the genuine ones are rough like a rasp, strengthened near the base with accessory valves and a thick interior margin, indicating that here is the great action, and here it is that the foot revolves, thus maintaining a rotatory motion, causing the valves to act as files upon the walls of its crypt and thus to enlarge it when necessary; perhaps this action may also be connected with its respiration and nutriment; it is probably very slow and gradual, so as not to injure the frail apex of its shells.

In another rock-borer, of a form not suited to effect an excavation by a rotatory motion, the deficiency, we see, is compensated for, and it effects its purpose by employing chemical agency when its crypt becomes too small for it.

The sand-boring razor-shell above described, would be impeded by a rough shell, in excavating its deep burrow, its valves therefore are smooth and polished, and its body very narrow, and consequently meets with less resistance in its motion either upwards or downwards—while the cockles which do not bore to a great depth are differently constructed and proceed in a different manner.

We next come to those bivalves which fix themselves to the rocks, or in other secure stations, by means of a *Byssus*, which is usually formed of brown silken threads, intertwined like wool, spun from the foot of the animal, formed from a slimy fluid furnished by a gland situated under its base. Poli says, with respect to the byssus of muscles, which have all of them this faculty, that it is of the same structure with hair, and that, at the extremities, it is furnished with little cups or suckers, by which it adheres so firmly, that the muscles can only be drawn from the water in great bunches. Some species are entirely enveloped with this substance. These provisions evidently indicate design and Creative Wisdom.

The giant *Clamp-shells*[1] belonging to the bimuscular section, sometimes four feet in length and weighing more than five hundred pounds, suspend their vast bulk by means of a strong byssus: below the hinge is a large opening, through which the animal passes a bundle of tendinous fibres, by which it is suspended to the rocks however large and weighty its shells, and thus it is enabled to fix itself securely, wherever its instinct directs it.

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[1] *Tridacne Gigas.*

These animals are said to be taken by means of a long pole, which is introduced between the valves of their shells when open; they immediately close them, and will not quit their hold, till they are landed. They are a principal article of food in the Moluccas, especially the young ones, which may be kept alive a long time.

The *wing-shell*[1] belonging to the unimuscular section, has long been celebrated, on more than one account, from a very early period. They are called wing-shells, or fin-shells, because they are shaped somewhat like a wing or fin, their Latin name (*Pinna*) is supposed to have been given them because of their resemblance to the plumes which the Roman soldiers wore in their helmets. They are sometimes very large, some are said to measure three feet in length: their substance differs from that of most shells, being of a fibrous structure, and they appear to be formed of transverse imbricated laminæ, they are also semi-transparent and very thin. Their byssus has been long celebrated, for it is mentioned by Aristotle.[2] Its Creator has provided this animal, as we learn from Poli, with a pair of bifid muscles with which it spins this substance, which emerges from the shell opposite the hinge; like the thread of the muscle it terminates in a sucker, and with it the animal adheres to the rocks and other bodies which it meets with at the bottom of the sea, and thus they brave the agitation of the waters. They seldom change their station, but they can unfix their byssus, if any circumstance renders such change imperative. In Sicily and Calabria this byssus, which is very silky, is manufactured into stuffs, stockings, and gloves, which are very fine and warm, but it will take no dye: articles composed of it are very dear, and the manufacture is fast declining. Aristotle observed a little crustaceous animal within the valves of the wing-shell, which he thought was nécessary to its existence. Pliny says it is always accompanied by a companion, the *Pinnotheres* or *Pinnophylax*, that when the Pinna opens its shell, a number of small fish boldly enter, and when it is full, the crab gives the blind animal notice by a slight bite, who immediately closes his shell, and assigns a portion of the prey to his little useful companion. Small Crustaceans indeed, both crabs and shrimps, certainly do find their way not only into the shells of the Pinna, but into those of muscles and whilks,[1] but their object is to defend themselves, especially when their crust is soft, and not to tell the Pinna when to close its doors upon its prey; for its food is the sea water or the animalcules it contains.

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[1] *Pinna*.

[2] See Appendix, note 24.

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[1] *Buccinum.*

Many other bivalves, which I need not particularize, spin a byssus with their foot. Singular it is that the same office should be assigned to organs so differently situated in different animals. The spinnerets of the silk-worm, and other spinning moths are in the *mouth*, those of the spider in its *tail*, and those of various shell-fish in their *foot;* in the first case, if we consider the various purposes to which caterpillars apply the faculty of spinning, we see the importance of its being under the direction of the eye of the animal: and even in the case of the spider, the eye directs the animal in its course to form its concentric circles, and the thread follows it; and the same is the case when it spins the rays that traverse its web; and when it descends from a height the same takes place. But the foot is the only organ that is so situated in bivalve shells, as to throw forth a thread that will go *out* of the shell, where it is wanted for use.

Of all this tribe of shells none are more beautiful, both as to their form, painting, and sculpture, than what are called *Escallop* shells, or *Comb* shells[1] from their resemblance, as to the scoring of the upper valve, to that instrument. These may be regarded as, in some degree, analogues of the butterflies amongst insects, and their flying as it were, on the surface of the water, as we shall soon see, increases the resemblance. There is, however, a difference between the Condylopes or annulose animals and the Molluscans, which must strike every examiner, the latter cannot be called symmetrical animals, while in the former the most perfect symmetry, both as to number of parts, and their structure, general form, sculpture and painting, prevails; in the latter this general symmetry seems not to obtain; in the *bimuscular* bivalves, indeed, the two shells are generally symmetrical both in form, size, and sculpture, but this does not invariably take place. In many of the *unimusculars* the upper shell differs from the under, either in size or other particulars; in the escallop shells it is much flatter and more ornamented as to colouring; and in the animal itself it is not a general principle that each part shall have its counterpart, or, if single, that the two sides shall exactly correspond. This furnishes some addition to the other proofs of the superiority of the Insect over the Molluscan tribes; symmetry, especially of the external organs and parts, distinguishes all the higher classes from man downwards; but is continued in the invertebrate sub-kingdom no further than the Condylopes, when it is interrupted or altogether ceases. It must be observed, however, that in the animal of the univalves, a beginning of symmetrical organs appears in the tentacles, which are in pairs mutually corresponding, a circumstance not discoverable in the bivalves.

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[1] *Pecten.*

The escallop shells were considered by Linné as belonging to the same genus with the oyster, which he regarded as a kind of rustic tribe belonging to it; but they not only differ widely in their shells, but also in the animal they contain. The mantle of the former is stated to be composed of two large membranes surrounded with long white hairs, and with pedunculated eyes: whence Poli denominated the animal of this shell "*Argus;*" but these assuredly are not real *eyes*, but probably eye-like organs or tentacles, useful to the animal, perhaps, as organs of investigation and prehension, but not of vision. Lamarck, who does not, *in loco*, mention this formation of the animal of the escallop shells, observes that the *Spondyls*[1] have the margin of the mantle furnished with two rows of tentacular threads, a structure that seems to indicate some investigating office or prehensory function resident in that part, perhaps like the tentacles of the polypes they may seize animalcules. The animal of the oyster has nothing akin to this, a sufficient proof, added to their very different shells, that they belong to different genera.

The French call these shells pelerines or pilgrims, they are also in catholic countries, especially in Spain and Portugal, called shells of

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[1] *Spondylus.*

St. James, because the pilgrims to the shrine of St. James of Compostella, in Galicia, were accustomed to ornament their cloak and hat with them.

I shall next make some observations upon the bivalve just mentioned, the oyster, which of all shell-fish, though it is one of the rudest and least sightly, has from every age been most in request, as a favourite article of food. This gift of Providence is widely dispersed, being found on the coasts of Europe, Asia, and Africa; those that frequent our own are reckoned the best of all. They are not a roving animal, but when they leave the matrix, they fix themselves to rocks or any substance that falls in their way, which they seldom quit. Like other Molluscans, they are hermaphrodites, and are stated by Poli, the great luminary of conchology, to contain 1,200,000 eggs, so that a single oyster might give birth to 12,000 barrels!! Providence has thus taken care that the demands made upon them to gratify the appetite of his creature man, shall not annihilate the race. These also are the only shell-fish that man has thought it worth his while to cultivate, by keeping them in certain pits formed for the purpose, called amongst us *beds*, and to which the salt water is admitted only at high tides: and these the green oysters are said to be produced; marine plants of that colour, the growth of which is favoured by the tranquillity of the water in these tanks, generate a vast number of seminiform germes, which entering the shells of the oysters when they open them to take their food—so it is stated—stain them with their own hue.

They have other enemies besides man: whoever has observed their shells will often see them quite covered with a small kind of sea-acorns.[1] It is related also that certain crabs get into their shells, first introducing a piece of stone to hinder them from shutting, but this is probably fabulous; they may, however, when the oysters open their shells to receive the sea-water, enter them as they do those of the muscles and the wing-shell, either for protection or for the sake of food. It is observed that the oyster defends itself against intrusive enemies by squirting upon them with force water kept in reserve in their shells; they keep out those that attempt to pierce their shells to get at them, by thickening them in the part attacked.

I shall next give some account of a bivalve that has interested mankind from a very early period of history, on account of the valuable gem that it produces, and which is frequently mentioned in Holy Scripture. The Supreme Being, in his goodness and attention to the wants and tastes of his principal creature, has not neglected to furnish him with various articles for ornament as well as for use: and the most valuable of all possessions, the kingdom of grace in the heart, is symbolized by a *pearl* of great price; and though the apostle charges females not to adorn themselves *with gold or pearls, but with good works*, the meaning of the passage is, that the latter should have their *first* attention, not to forbid absolutely the use of the former—they are to adorn themselves not so much with gold or pearls as with good works—which ought to be the object of their most sedulous care.

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[1] *Balanus*, &c.

The animal that produces pearls in the greatest abundance, of the purest nature, and of the highest value, was by Linné classed with the muscles,[1] but Lamarck has formed it into a distinct genus which he names *Meleagrina*. In this country it is usually called the pearl-oyster. It inhabits the Persian Gulf, the coasts of Ceylon, the sea of New Holland, the Gulf of Mexico, and the coasts of Japan. It attains perfection no where but in the equatorial seas, but the pearl fishery in the island of Ceylon is the most celebrated and productive; it is on the west coast, off the bay of Condatchy, where the country is very sandy and nearly without inhabitants, but on these occasions a populous town, with many streets a mile long, appears to have suddenly started up. The oyster beds or banks extend over a space thirty miles long by twenty-four broad. The twentieth of February is generally the day of rendezvous for the fishermen. The fishery is commonly rented by a single individual, who is allowed to employ 150 boats for thirty days, there are about 6000 boatmen and attendants. The oysters vary in their qualities according to the nature of the ground to which they are attached; and also in their number, by the action of the tides and other circumstances: those at the greatest depth produce the largest pearls, which are situated in the fleshy part near the hinge. Pearls consist of concentric coats of the same substance as that which forms the mother-of-pearl of the shell; they are produced by the extravasation of a lapidifying fluid, secreted in the organs of the animal and filtered by its glands. For one pearl that is found perfectly round and detached between the membranes of the mantle, hundreds of irregular ones occur attached to the mother-of-pearl like so many warts: they are sometimes so numerous that the animal cannot shut its shell, and so perishes. The pearl is a formation forced upon the animal by some annoying substance in its shell, which it covers with mother-of-pearl, as the bees do intrusive wasps with wax, to fix it or hinder it from affecting them by putridity, &c. Sir E. Home is of opinion that the abortive eggs of the animal are the nucleus upon which the pearl is formed, and he has made it very probable that this is often or generally the case, but still the process just mentioned may take place when accidental substances are introduced, and produce the warty excrescences, and sometimes loose misshapen pearls.

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[1] *Mytilus margaritiferus.*

The diving tackle consists of a large stone suspended by a rope with a strong loop above the stone to receive one foot of the diver, and having also a slip-knot, and a basket formed of a hoop and network which receives the other foot. When he has fixed himself in this tackle and is duly prepared, he holds his nostrils with one hand, and pulling the running-knot with the other, instantly descends—when he reaches the bottom he disengages his foot from the stone, which is immediately drawn up to be ready for the next diver. He at the bottom throws himself on his face and collects every thing he can lay hold of into the basket—when ready to ascend he jerks the rope and is speedily hauled up, and working himself up the rope he arrives at the surface sooner than the laden basket. A minute and half or two minutes are the utmost any diver remains under water. The shark-charmers form a necessary part of the company, by their incantations they are supposed to possess the power of preventing these voracious fishes from attacking the divers, and they will not descend without their attendance; where the bed is rich the diver often collects 150 oysters at one dip, but sometimes not more than five.[1] It is said that a single diver will, in one day, often bring up from 1000 to 4000 oysters.

From the simple circumstance that Providence has instructed this animal, which cannot eject from its shell those substances, whether formed within itself, or that have accidentally entered, to encase them in the precious substance which it is empowered to secrete, what a vast fund of ornament to deck the most lovely part of the creation, and having no parallel in any gem that the earth produces, is provided. The pearls obtained from other shell-fish vary in colour—those from the wing-shell are brown, and those from the fresh-water muscles greenish, but sometimes they are yellow, pink, bluish, and some are even black; these last are very rare and dear.

Other bivalves fix themselves by a tendinous ligament to the rocks. In one genus,[2] in the upper valve near the hinge, is an aperture, closed by a kind of operculum formed at the dilated extremity of an internal muscle, it is by this operculum that the animal fixes itself. In another, related to the last,[3] the beak of the lower valve turns up, overhanging in some degree the upper valve; in this beak is a notch or aperture through which the fixing tendon passes; affording an admirable instance of variation in the means of attaining the same end, when circumstances require it. It was necessary that the valves should not be reversed, a tendon through the lower valve secures this in the first of these animals; but in the second, where the overhanging beak would interfere with this purpose, the tendon issues from the beak itself, so as to enable the animal still to fix itself with the proper valve downwards. In the *Anomia* the valve takes the form of the substance it is fixed to.

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[1] Malte-Brun, *Geogr.* iii. 225.

[2] *Anomia*, PL. V. FIG. 2, 3.

[3] *Terebratula*, PL. V. FIG. 4.

Who would think that these headless animals, unprovided with organs that indicate any of the higher senses, as sight, smell, and hearing, and apparently fitted with no other means of motion than those of opening and shutting the valves of their shells, or travelling very slowly for a few inches, should yet be able not only to leap and use other motions, but occasionally to sail gaily on the surface of the ocean; but, however improbable this may seem, it has been proved to be the case by the evidence of eye-witnesses of the fact.

The common cockle,[1] Poli says, can not only, by means of its foot turn round, or to either side, but even take a good leap. The Trigons,[2] nearly related to the cockle, are mostly fossils but there is one recent species, found on the coast of New Holland, called originally, from the pearly lustre of the inside of its shells, the pearl trigon,[1] a name changed, without reason, by Lamarck. This, which was originally taken by Lesueur and since by Capt. King, was more recently brought from thence by Mr. Setchbury, who told me, that they would leap over the gunwhale of a boat in which he was, to the height of above four inches. The foot of this animal is bent at an acute angle, so, as upon pressure, to form a very elastic organ,[2] and that of the cockle is nearly the same.

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[1] *Cardium edule.*

[2] *Trigonia.*

Those elegant shells the Pectens, or comb-shells, have long been celebrated for their motions. Pliny says, probably meaning these shells, that they leap and flutter out of the water, and dive. D'Argenville relates, that when they are on shore, they regain the water by opening the valves of their shells as wide as they can and then shutting them briskly, by which they acquire sufficient elasticity to rise three or four inches, and thus proceed till they accomplish their object. Most probably the foot assists in producing these leaps. Their progression in the water is described as very different; when they rise to the surface—but the means by which they do this has not been clearly explained—they support themselves half under water. They next open their shells, to which they communicate such a vibration, that they acquire a very brisk movement from right to left, which enables them, as it were, to run upon the water.

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[1] *T. margaritacea.*

[2] PLATE V. FIG. 5.

The tulip-shell,[1] when it walks, if I may so speak, opens and shuts its valves, and at the same time lengthens and shortens its foot, which seems to indicate a connection, or action, between the former and the latter organs, similar to what has been observed to take place in insects, and perhaps points out some analogy between the valves of the shell and the upper wings, or elytra of insects, and the mantle and their under wings.

Bosc states, that the animals of the genus Venus, in calm weather, may be seen sailing on the surface of the waters, using one of their valves as a boat and the other as a sail. As these are usually rather heavy shells, they must be furnished with some means of rendering themselves lighter than the water. Pliny, of old, mentions shells dedicated to Venus, which sail and oppose their concave part to the wind.

Thus we see the Creator has given even to these apparently stupid and inactive creatures means of enjoyment, that every one is not aware of; and powers of locomotion, of which, at first sight, they seem incapable.

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[1] *Tellina.*

I might enlarge here on the admirable contrivance and variety observable in the hinge, as it is called, by means of which the animals are enabled to open and shut the valves of their shells; upon the sculpture and colours that distinguish many of them, particularly amongst the unimusculars, but this chapter is already too long, and enough has been said to prove that they have in no respect been neglected or overlooked by the Almighty Being who willed their existence, and who is ever watchful over the creatures of his hand, to provide them with all things necessary for their being, consistently with the ends he created them to serve.

Chapter IX.

Functions and Instincts. Univalve Molluscans.

The *Univalve* shells of the Swedish naturalist, a term adopted from Aristotle's *Monothyra*, are next to be considered; these, with the multivalve *Chitons*, form the *Gastropods*, or shell-fish using their belly for a leg, of Cuvier; and with the cuttle-fish and nautilus tribe constitute Lamarck's Class of *Molluscans*. The latter author divides his Class into five orders, four of which belong to the tribe I am considering.

1. *Pteropods* (wing-footed); furnished with organs only for swimming and sailing.[1]

2. *Gastropods* (belly-footed); body straight, never spirally convolved; a muscular foot for creeping under the belly.

3. *Trachelipods* (neck-footed); greatest part of the body spirally convolved; always inhabiting a spirivalve shell; foot free, attached to the neck, formed for creeping.

4. *Heteropods* (diverse-footed); no coronet of arms; no subventral, or subjugular foot; fins, one or more, not disposed in pairs.[2]

As the Cephalopods, forming Lamarck's fourth Order, may be regarded rather as constituting a larger division or Sub-class of the Molluscans, than an Order, I shall consider them in a separate chapter.

1. Proceeding from one of the above Orders to another, I shall select such individuals, belonging to it, as appear to exemplify the great attributes of their Creator, either in their structure, forms, habits, or instincts. The animals of the *first* Order, like the long celebrated Argonaut and Nautilus, enliven the surface of the ocean

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[1] Plate V. Fig. 6, 7.

[2] Fig. 8.

in fine weather, where they steer their little barks through, between, and over its fluctuating waves, and spread their membranous sails to the soft breathing of the zephyrs.

One of the most noted animals of the tribe is known by the appellation of the Boreal Clio, which, like the jelly-fish, has a gelatinous body, is defended by no shell, and affords food to the whales and other fishes, as well as to the sea-birds. This animal is abundant in places that suit it, and appears only during the warmest hours of the day on the surface.

Other genera of this Order are covered by a shell or shells. Of this kind is the genus *Hyalæa*, so named from its semi-transparent shell, which wears the appearance of a bivalve with soldered valves, the upper one being the largest; this difference of size of the seeming valves causes an aperture through which the animal sends forth two large yellow and violet wings, or sails, rounded and divided at their summit into three lobes. The head in this genus is almost evanescent, so that both shell and head exhibit an easy transition from the acephalous or bivalve Molluscans to those which have a head. When its wings or sails are unfolded it moves with great velocity on the surface of the sea. The animals of this Order, both from the beautiful colouring of their filmy sails or wings, and from their number and symmetry, are better entitled to the appellation of the butterflies of the ocean, than the escallop shells which have sometimes been so called. The mantle of the bivalves becomes an organ of very different use in the *Pteropods;* for they, having no means of fixing themselves like most of the bivalves, float continually in the ocean; to compensate for this want, as in innumerable other instances, their Creator has given them the power of expanding this organ as a sail, both for motion and to give some direction to their course; it is attached to the mouth or neck, and is connected in some species with their respiration. Nothing certain is known with respect to their food: probably they absorb the animalcules swarming in the sea-water.

2. The series of *Gastropods* begins with animals that have no shell, amongst which the most remarkable seem to be the *Scyllæa* and the *Tethys*, both known to Linné, and by him described. The former is an oblong gelatinous animal, laterally compressed, elevated above in the middle, where it has two pair of membranous wings or fins. Its inferior surface is hollowed out longitudinally, by means of which, and its tentacles, it can embrace the stems of the fuci or sea-wrack, the flowers of which it eats. It is described as moving very slowly in the water by bending its extremities. It swims on the surface when the weather is calm, but adheres to the

floating fuci when the sea is agitated, so that the kindness and foresight of its Maker—by giving it wings, for independent motion, and means to adhere to the fuci, when support is necessary to it, or it takes its food—has thus provided amply for its enjoyment and sustenance. The great peculiarity of the latter, the Tethys, is a mantle which extends above and beyond the head, like that of some marine goddess, concealing it entirely, and forming an ample veil, fringed or undulated at its margin. By the help of this veil they elevate themselves to the surface, and probably sail on the waters. This animal is nearly related to the *Laplysia*, a kind of sea-slug, like which it lives in muddy places, and ejects a black fluid; it is very fetid, and its flesh is poisonous. It only rises to the surface in the hot season.

I shall next notice a tribe of Gastropods, which at first sight, considering the number of pieces of which their shelly covering is composed, seems to belong to the multivalves, amongst which Linné has placed it. It will be readily perceived that I am speaking of the *Chiton*, or *coat-of-mail* shell, but when the animal that it covers is examined, it will be found that, notwithstanding its multivalve shell, it really belongs to the Gastropods.

These animals are generally found under stones, sometimes they adhere to the surface of rocks, and sometimes conceal themselves in their fissures: they often traverse vast tracts of ocean fixed to the keels of ships, like some of the limpets they fix themselves a good way out of the water, so as only to be wetted when the tide is up, and sometimes above high water mark. Poli says that when they resist any attempt to force them from their station, they expel the air and water on all sides and produce a vacuum, so that it is very difficult to overcome the pressure of the atmosphere; and Mr. Frembly, who had an opportunity of studying their habits on the coast of Chili, states that when not apprehensive of danger their attachment is very slight, and by pushing them gently they will easily slide from the surface to which they are attached, but if a direct attempt is made to unfix them by force, they will part with a portion of their shells sooner than let go their hold.

When we consider that these animals are not only often exposed to the violent action of the waves, but also to the attack of countless enemies, we see abundant reason for the coat of mail with which their Creator has covered them. Even the fleshy or cartilaginous margin, or zone, as my lamented friend the Rev. Lansdown Guilding, in his admirable memoir on this tribe, denominated it, is defended sometimes by scales, spines, and bristles, at others rough with numerous little bony tubercles; it is also described as in general fringed, so that when the animal attaches itself to a rock or stone, it is altogether calculated, by the application of the prone part of its body, to produce a vacuum. The wing-shell and other bivalves that suspend themselves by a byssus, are sufficiently protected by their shells from the attack of their enemies, without so complete an adhesion of the body as is necessary for the coat-of-mail shell. Mr. Guilding, who had excellent opportunities of observation, informs us that these animals are night-feeders, remaining stationary as above, during the day; reasoning from analogy he suspects they feed on marine plants, the sea-wrack, &c. These creatures slide along very slowly, if accidentally reversed, they recover a prone position by the violent motions of the ligament or zone that surrounds them, and if alarmed they sometimes roll themselves up like woodlice.

Lamarck proceeds immediately from the Chitonidans to the *Patellidans* or Limpets,[1] which also fix themselves so firmly to the rock, that it requires considerable force to separate them, and sometimes in such numbers that their surface seems quite covered by them. The transition from the former tribe to this, with no intermediate links, seems at first sight violent, and their right to be associated in the same family rather problematical: probably intermediate species will come to light which will render this point more evident than the shell of these animals appears to indicate.

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[1] *Patella.*

With regard to their functions and the part assigned to them in the great plan of creation, little is known; probably, from their numbers in some parts, they may help to soften the rocks, so that they may, at some destined hour, yield more readily to the force of the winds and waves; thus they may be enumerated amongst the instruments which the Creator employs to effect his purposes, and such changes in the coast of any country, as he wills shall take place.

They afford a beautiful instance of the gradual progress of Creative Wisdom from form to form. If the student of the tribe looks with inquiring eye at a collection of the Patellidans, or limpets, in the flattest and most depressed of them[1] he will find no small resemblance to one of the valves of a bivalve shell, he will soon, however, discover a prominence in it, the first tendency towards the spiral convolution, a little removed from its centre, which will prove to him that it belongs to a very different tribe; looking again at others that are more elevated and conical,[2] he will see the same prominence or beak forming a more striking feature, and ascertaining these shells to be univalves, he will find, upon a comparison of them with the nerit,[1] the snail,[2] or the periwinkle,[3] that this umbo or knob is analogous to the spiral part of those shells, as he will see upon examining one of the bonnet-limpets,[4] in which he will detect an incipient decurved spire; passing from this by one of the chambered-limpets,[5] it will lead him to the neritidans, or top-shells, from which the road is direct to the sea-ear;[6] and by another[7] he arrives almost immediately at the periwinkles and snails. If he chance to examine further between the limpets and the whelks,[8] he will find another open shell,[9] which forms the path to the latter genus. If once more his eye happens to observe a shell almost open[10] but with the sides a little turned in, he will see still another road leading by the dippers[11] to the elegant tribe of cowries.[12] It is by this road that Lamarck travels to them. Again, he may perhaps be shewn, preserved in spirits, an animal whose respiratory orifice is covered by a round shield—this is the sea-slug,[13] an animal famous for Pliny's legend of its noxious qualities, whose head resembles a hare, which leads from the Patellidans towards the common slug of our gardens.[14] To the bivalves there seems to be also a road from this central group, by a Norwegian shell described by Müller as an anomalous species of limpet, but which by Lamarck is considered to be a bivalve.[1] The lower valve in this genus is so thin that Müller overlooked it; by it the animal adheres to marine bodies—the upper valve, like the *Patella*, is sub-conical with a prominent vertex, and the two valves are not connected by a hinge.

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[1] *Umbrella indica.*

[2] *Patella vulgata.*

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[1] *Nerita, Neritina, &c.*

[2] *Helix.*

[3] *Turbo.*

[4] *Pileopsis ungarica, &c.*

[5] *Crepidula.*

[6] *Haliotis.*

[7] *Calyptræa.*

[8] *Buccinum.*

[9] *Concholepas peruviana.*

[10] *Bullæa.*

[11] *Bulla.*

[12] *Cypræa.*

[13] *Laplysia depilans.*

[14] *Limax.*

A due consideration of all these circumstances, of this radiation, as it were, from a typical form as a centre, by various roads towards different tribes, seems to prove, and the observation is confirmed by facts in other departments of nature, that the world of animals, as well as that of heavenly bodies, consists of numerous systems each, so to speak, with its central orb, and all concatenated, and revolving as it were wheel within wheel, and all tending towards or branching from a common centre. It seems, in the present instance, taking the group expressed by *Patella* of Linné as the common centre, that from thence, though by different and diverging routes, we may arrive at almost every molluscan group or tribe.

The Molluscans that we have hitherto been considering, with the exception of the herbivorous chitons, derive their nutriment from the sea water itself, either from animalcules or other marine substances requiring only absorption, but the Gastropods that we are next to notice live upon more solid food, and such as cannot be digested without a more powerful action upon it. Of this description are the dippers[1] which are furnished with a singular organ or gizzard that proves their predaceous or carnivorous habits; the remaining genera are herbivorous, but as they exhibit no very interesting traits I shall proceed to the next Order.

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[1] *Orbicula Norwegica.*

The *Trachelipods*, constituting Lamarck's third Order of Molluscans, may be divided into those that are *herbivorous*, and those that are *carnivorous*, the first having no respiratory siphon, with which the others are furnished.

The herbivorous Trachelipods may be subdivided into *terrestrial* and *aquatic*, and the latter into those that inhabit fresh water or salt. It is not known that any of the predaceous ones are terrestrial. The terrestrial ones not only devour the leaves and stems of plants, but some also attack their *roots*, one species, defended by an operculum or mouth-cover, devours those of the violet.[2] Others of this tribe are found on trees, under moss, or feeding on the lichens; the shells of some of these are what are called turrited[3] or long and slender, with spiral whirls,

[1] *Bulla.* [2] *Cyclostoma elegans.* [3] *Clausilia.*

resembling, in miniature, a lofty tower with a spiral staircase winding round it. By this attenuated structure their motions, in their close retreats, are less impeded. As it is in this tribe of univalves that the organ just mentioned, the *operculum*, or mouth-piece, first makes its appearance, it will not be improper here to give some account of it.

If we survey the various tribes of shell-bearing animals we find them defended from the injuries or attacks, to which their situation exposes them by various expedients, all of them indicating Power and Wisdom in their contrivance and formation, and Goodness in their end. These animals themselves all have a soft body furnished with organs of different kinds, suited to their station and purposes. Those that are below them in the scale, especially the naked Polypes, and gelatinous Radiaries, are still more frail and evanescent, but their organization is so inferior, that it is probably less subject to derangement from external accidents, or injuries are sooner remedied, than in that of the shell-fish —which, unless they were clad in some kind of mail, would probably soon perish. Accordingly we find some protected by a multivalve tubular shell,[1] the inhabitant protruding its organs at the summit, which is defended by an operculum consisting of more than a single piece—in others, also, the shell is multivalve, but the animal protrudes itself at the sides, and has no operculum, as in the common barnacle.[1] Others, again, are protected by a shell consisting of two valves, open at one or two ends, and these seek further protection either by burying themselves in the sand or perforating the rocks, or by suspending themselves by a byssus; others, again, which only open their shells at certain times, as the oyster, fix themselves to any convenient substance. To these succeed others, whose shell is transversely divided into many pieces,[2] but yet, taken together, it forms a single valve protecting the back of a gastropod, or slug-like animal, which for further protection, when it is not moving, and to supply the place of a lower valve, fastens itself to a rock or other substance.

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[1] *Balanus. Tubicinella.*

With the Patellidans begin the undivided univalve shells, which like the preceding animals protect their lower side by fixing themselves to the rocks; the sea-ears,[3] which are still more open, have recourse to a similar mode of protecting themselves, they preserve a communication with the atmosphere or water without elevating their shells, by means of a line of apertures, under the thickest margin near the apex; these apertures begin when the animal is young near the spire, and as it grows it stops up one and opens another, as its occasions require. I have a very large specimen, in which there are traces of eighteen apertures, and all but six are stopped up. If we turn our eyes from these to the Buccinidan or Whelk tribe, we are struck by an open Peruvian shell, which at first sight seems like a limpet,[1] but upon inquiry we find that it is defended by an operculum, the plan of protection being here changed, and, instead of an under-valve, or a rocky munition, it is closed by a broad plate, which some peculiarity in its structure and organization doubtless required; from this by *Purpura* and *Monoceros* to the true *Buccinum*, the mouth narrows and the operculum with it.

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[1] *Pentelasmis.* [2] *Chiton.* [3] *Haliotis.*

If we examine the common periwinkle, we find the mouth of its shell closed by a horny organ called the *patch*, which is attached to the foot or rather neck, by its convex or lower surface, sitting on a sub-triangular flat space spirally convoluted; this is the *operculum*, and if examined on either side will be found to be also spirally convoluted, proving that it is formed by the part on which it sits. When the animal expands its foot for creeping, the operculum is retracted within the shell, so as to be quite out of the way. If we examine the opercula of other shells, we shall find that the majority of them have the same spiral configuration traced both on the upper and lower surface. In most that I have seen the intervals of the whirls increase in width, as the spires of the shells do from the base to the mouth. In the top-shell[1] the whirls are perfectly regular and nearly equidistant. They vary much in thickness; I have one three-fourths of an inch thick, while those of the top-shell and periwinkle are very thin. In some of the thick ones, on the under side the convolutions are very convex, and sometimes elevated into concentrical ridges. Some underneath have a forest of obtuse elevations, and many are rough with minute tubercles. As to substance some are horny, while others resemble the shell; others are horny externally and shelly internally. If these formations on the under side, as in the common periwinkle, represent the shape of the part of the neck to which they are attached, as they most probably do, it must act the part of a mould, upon which the operculum is formed from its mucus, and increased as the aperture enlarges.

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[1] *Concholepas.*

Lamarck is of opinion that the shell of univalves is formed in a similar way upon the *neck* of the animal, which in the *Murices* or rock-shells, and other tribes distinguished by spines or tubercles, has certain fleshy processes which produce those spines, &c. and is withdrawn when they have acquired consistence enough not to bend when thus left to themselves. Other conchologists, particularly one of the most eminent of our times, Poli, think that the shells of univalves are organized bodies, and produce their spines as vegetables do their prickles, he says also that their shells contain cellular membranes almost like a *Rete mucosum*.

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[1] *Trochus*

In the progress of a shell's growth, as new spines are formed old ones drop off, how this is effected seems not to be accounted for by either hypothesis—it is analogous, however, in a great degree, to what was mentioned above with regard to the holes in the shell of the sea-ear, only that with them an old hole is stopped up, when a new one is formed. All that can be said on the subject is that the animal, instructed by Providence, as new processes are formed and a new whirl of its shell completed, is enabled to throw off by a solvent, or some other means unascertained, those that are no longer wanted.

It is observable that the terrestrial univalves,[1] of this Order, are never armed with spines, tubercles, or other elevations, but exhibit generally a levigated shell. As they move about usually amongst bushes, under moss, or in grass, the object of the Creator in this structure was probably that their motions might not be impeded by any roughness of their shell.

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[1] *Helix*, &c.

Mr. E. W. Brayley, in a very ingenious memoir, in the Zoological Journal, has contended, with considerable strength of argument, that the moveable black points, in the upper tentacles of snails, though he allows they may be their analogues, are not real eyes; but the Rev. L. Guilding, in a subsequent part of the same Journal states, that the large strombs of the Caribbean sea have eyes furnished with iris and pupil, similar to those of birds and reptiles—that they have also a vitreous and aqueous humour, and a black pigment, which certainly prove them to be real eyes—their organ of hearing, he thought, was likewise distinct. The cowries also are said to have eyes exhibiting both iris and pupil, as have some volutes.[1]

Giving these facts their due weight, I think we may conclude that the, so called, eyes of snails, are real though imperfect visual organs. It appears to be the plan of the Creator,

. . . . to ascend
From small beginnings to a glorious end.

An organ is, as it were, sketched out, in the lowest animal, as for instance, a nervous system, which keeps developing and improving till it is brought to its acme in the highest: first we find in the polypes no nervous centre, but molecules every where dispersed; then the next form is a nervous collar round the œsophagus; next dispersed ganglions; then a ganglionic chord; and so on till we arrive at a regular brain and spinal marrow incased in a vertebral column. We may with reason therefore conclude, that the organ of vision, when first planted, would be a mere rudiment, though sufficient for the animal's purposes, and possessing few of the characters it exhibits when arrived at its most perfect form; these it keeps acquiring, as it becomes more developed, or to avoid misconception from nibbling critics, the Creator keeps giving it more and more perfect sight till he brings it forth, in all its glory, in the highest animals.

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[1] *Voluta ethiopica*, PLATE VI. FIG. 1. *a*.

The most common in this country of these herbivorous Trachelipods, is the garden-snail,[1] but the species whose history has been most copiously related, is that called in France the *Escargot*,[2] which, though stated to have been originally imported into this country, now abounds in some parts of Surry and other southern counties. I shall begin by giving some account of their economical and then of their physical history.

On the continent, especially in France, this large snail, which is more than double the size of our garden one, is used as an article of food, and though said not to be easy of digestion, is very palatable. They are thought to be in best season in the winter, when they are hybernating, and covered with their temporary calcareous operculum, which falls off in the spring. The Romans appear to have fattened these snails, in places appropriated for that purpose. Pliny mentions several sorts that were kept separate, and amongst others white ones that were found in the neighbourhood of Rieti. The Illyrian snails he describes as the largest; the African as most prolific; others from Soletum, in the Neapolitan territory, as the noblest and best: he speaks of some as attaining to so enormous a size, that their shells would contain eighty pieces of money of the common currency.[1] Bruguières, to whom conchology is under very great obligations, is of opinion that, by cultivation, the several species of snails might be brought to a much greater size, and furnish an abundant, wholesome, and even delicate aliment. There is no reason why the species of this genus, which feed on vegetable substances, should not be as palatable as the oyster or periwinkle.

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[1] *Helix hortensis.*

[2] *H. Pomatia.*

Snails, in general, are hermaphrodites, or unite both sexes in the same individual: this is the case with the great majority of Molluscans; the object of Providence, in this kind of organization, is evidently the greater multiplication of the species, but though hermaphrodites, in each individual possessing the organs of both sexes, they are not so as to sexual union; reproduction can only take place when different individuals impregnate each other; this union takes place at the beginning of the spring, sooner or later, according to the heat of the season. Their courtship is singular, and realises the Pagan fable of Cupid's arrows, for, previous to their union, each snail throws a winged dart or arrow at its partner. About twenty days after coupling the snails lay, at different times, a great number of white eggs, varying at each laying from twenty-five to eighty, as large as little peas, enveloped in a membranous shell, which cracks when dried. They lay these eggs in shady and moist places, in hollows which they excavate with their foot, and afterwards cover with the same organ. These eggs hatch, sooner or later, according to the temperature, producing little snails exactly resembling their parent, but so delicate that a sun-stroke destroys them, and animals feed upon them; so that few, comparatively speaking, reach the end of the first year, when they are sufficiently defended by the hardness of their shell. The animal, at its first exclusion, lives solely on the pellicle of the egg from which it was produced. Providence, which in oviparous and other animals, has provided for the first nutriment of the young in different ways, appropriating the milk of the mother to the young of quadrupeds; the yolk of the egg to those of birds, tortoises, and lizards; and the white of the egg to frogs and toads, has made this pellicle or coat the best nutriment of the young snail. In fact, this pellicle, consisting of carbonate of lime, united to animal substance, is necessary to produce the calcareous secretion of the mantle, and to consolidate the shell, as yet too soft for exposure. When this envelope is eaten, the little snail finds its nutriment, more or less, in the vegetable soil around it, and from which it continues to derive materials for the growth and consolidation of the shell. It remains thus concealed for more than a month, when it first issues forth into the world, and without respect of persons, attacks the vegetable productions around, returning often to an earthly aliment, probably still necessary, for the due growth and hardening of its portable house. These snails cease feeding when the first chills of autumn are felt, and associating, in considerable numbers, on hillocks, the banks of ditches, or in thickets and hedges, set about their preparations for their winter retreat. They first expel the contents of their intestines, and then concealing themselves under moss, grass, or dead leaves, each forms, by means of its foot, and the viscid mucus which it secretes, a cavity large enough to contain its shell. The mode in which it effects this is remarkable; collecting a considerable quantity of the mucus on the sole of its foot, a portion of earth and dead leaves adheres to it, which it shakes off on one side; a second portion is again thus selected and deposited, and so on till it has reared around itself a kind of wall of sufficient height to form a cavity that will contain its shell; by turning itself round it presses against the sides and renders them smooth and firm. The dome, or covering, is formed in the same way: earth is collected on the foot, which then is turned upwards, and throws it off by exuding fresh mucus; and this is repeated till a perfect roof is formed. Having now completed its winter-house, it draws in its foot, covering it with the mantle, and opens its spiracle to draw in the air. On closing this, it forms with its slime a fine membrane, interposed between the mantle and extraneous substances. Soon afterwards the mantle secretes a large portion of very white fluid over its whole surface, which instantly sets uniformly, and forms a kind of solid operculum like plaster of Paris, about half a line in thickness, which accurately closes the mouth. When this is become hard the animal separates the mantle from it. After a time, expelling a portion of the air it had inspired, and thus being reduced in bulk, it retreats a little further into the shell, and forms another leaf of mucus, and continues repeating this operation till there are sometimes five or six of these leaves forming cells filled with air between it and the operculum.

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[1] *Quadrans.*

The membranous partitions are more numerous at the end than at the beginning of winter, and, in snails inhabiting the mountains, than in those on the plains. These animals hybernate at the proper period, at very different temperatures, varying from 37° to 77° Fahrenh. Respiration ceases during the period of hybernation.

The mode in which these animals escape from their winter confinement is singular: the air they had expired on retiring into their shell further and further, remains between the different partitions of mucous membrane above mentioned, which forms so many cells hermetically sealed; this they again inspire, and thus acquiring fresh vigour, each separate partition, as they proceed, is broken by the pressure of the foot, projected in part through the mantle; when arrived at the operculum they burst it by a strong effort, and finally detaching it, then emerge, begin to walk and to break their long fast.[1]

In all these proceedings the superintending care and wise provisions of a Father Being are evident. This creature can neither foresee the degree of cold to which it may be exposed in its state of hybernation, nor know by what means it may secure itself from the fatal effects it would produce upon it, if not provided against. But at a destined period, often when the range of the thermometer is high, not stimulated by a cold atmosphere, except, perhaps, by the increasing length of the night, at the bidding of some secret power, it sets about erecting its winter dwelling, and employing its foot both as a shovel to make its mortar, as a hod to transport it, and a trowel to spread it duly and evenly, at length finishes and covers in its snug and warm retreat; and then still further, to secure itself from the action of the atmosphere, with the slimy secretion with which its Maker has gifted it, fixes partition after partition, and fills each cell formed by it, with air, till it has retreated as far as it can from every closed orifice of its shell—and thus barricades itself against a frozen death. Again, in the spring, when the word is spoken—*awake, thou that sleepest*—it begins immediately to act with energy, it reinspires, as above related, the air stored in its cells, bursts all its cerements, returns to its summer haunts, and again lays waste our gardens.

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[1] Gaspard and Bell, *Zool. Jour.* i. 93.—ii. 174.

We may observe here, with respect to this and all hybernating animals, a beautiful relation and correspondence between their habits and their functions. Their official duty is to remove superfluities and nuisances, to prevent vegetable substances from encroaching too much upon each other, to remove entirely those that are dead and putrescent. At the season of the year, therefore, when the former are in full vigour, forth issue from their various retreats the innumerable tribes that make them their food, but when they cease to grow and flourish these services are not wanted, and the animals who perform them disappear from the face of nature. Again, when dead animals, or the excrements of living ones, or the sweets issuing from innumerable flowers, would clog the air that we breathe with effluvia unfriendly to health and life—countless armies are every where upon the wing, or on the alert, to prey upon such substances, and prevent their miasmata from breeding a pestilence amongst us; but when the cold season returns, the flowers lose their leaves and blossoms, and exhale no longer their sweets, and the scents arising from putrescent and other fœtid substances become no longer annoying. Then the whole army employed in this department disappears, and the face of nature seems to lose the most busy part of its population, gone to a long repose.

It is worthy of remark, with respect to the terrestrial animals of the tribe we are considering, that they all delight in shady and moist places, and that during hot and dry weather they seldom make their appearance, but no sooner comes a shower, than they are all in motion. It is probable that their power of motion is impeded by a dry soil, and that the grains of earth and small stones, when quite dry, adhere to their slimy foot.

As many of the marine shells appear in some degree amphibious, for instance, the *Chitons* and the *Limpets*, so, perhaps, some of the terrestrial ones may occasionally enter fresh waters; indeed the amber shells,[1] at least one species,[2] is stated to swim occasionally on the surface of the water. From these circumstances it seems not improbable that the shell-fish, as well as the birds, so vast a proportion of them being marine animals, were all amongst the objects created on the fifth day, and produced by the waters.

There are very large and beautiful shells found in South America, belonging to the terrestrial herbivorous section and to different genera[3] divided from *Helix* of Linné, but we know nothing of their history or habits, I shall therefore now say something upon the marine herbivorous Trachelipods.

The violet snail,[4] which, according to the account of its manners given by Bosc, who paid particular attention to them in a voyage from France to America, exhibits several very remarkable peculiarities. When the sea is calm, these animals may be seen collected often in large bands, swimming over the surface by means of a floating apparatus consisting of aërial vesicles, produced by their foot; and attached to its posterior part, a little below the point to which the operculum is fixed in other genera, and to which Cuvier thinks it bears some analogy,[1] who also observes that it has a natatory membrane or fin on each side of its body. During this action their head is very prominent, and the foot is so extended that the float or line of vesicles forms an angle with the middle of the shell. When the sea is rough, the animal absorbs the air from its vesicles, changes the direction of its foot, contracts its body, and lets itself sink. It does the same when in danger from any enemy, and further, like the cuttle-fish and some others, colours the water by the emission of a blue fluid, which serves to conceal it. They are vividly phosphoric in the night. Birds carry them off with great dexterity.

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[1] *Succinea.*

[2] *S. elongata.*

[3] For instance, *Achatina Bulimus, &c.*

[4] *Ianthina*, PLATE VI. FIG. 2.

If their floating apparatus is mutilated the foot can reproduce it. The latter is flat towards the head, this part of it is furnished with a transparent membrane, which extends far beyond its extremity, and is composed of a large number of vesicles of unequal size, those in the middle being the largest; these vesicles the animals fill with air at their pleasure. The violet-coloured shell of this little animal is remarkably thin, which facilitates its excursions on the surface. It is singular that under this fragile vesicular float a little line of pearly fibres may be perceived, to which are attached its eggs; in some species they are contained in little membranous bags or sacs. It is thought that the young animals, when liberated from these bags or chambers, ascend their mother's float, and so are transported to the surface. Fishes are enabled to rise to the surface of the water by means of their air-bladders, and some radiaries by a vesicle which surmounts them,[1] but neither of them are more singular than these outriggers by which the vessel of the violet-snail is kept both buoyant and steady.

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[1] PLATE VI. FIG. 2. *a*.

The foot of the Molluscans, when we first observe it, seems to us merely an organ of locomotion, nothing remarkable in its structure, and incapable of any multifarious action, but when we study the history of this and the preceding snail, we see that it is a most important organ, and which performs a greater variety of operations than almost any organ of any other animal. We have seen that it spins a fine silk and thread; that it secretes a fluid serviceable for several purposes; that it can form a float, as in the present instance; that it can be used as a hand in excavating and building, and various other manipulations, so that in giving them this instrument and endowing it with such variety of functions in the various tribes, their Creator gave them every thing they wanted.

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[1] See above, p. 195.

Perhaps the followers of Lamarck may say that, in the present instance, the animal constructs its own float itself, at the impulse of its own wants. But uninstructed by its Creator, how could it learn that vesicles full of air would serve to float its little boat, and if not already organized to answer the impulse of an exciting cause, in vain would the will of the animal, if so instructed, endeavour to produce and inflate the vesicles, or, when it willed to sink, to empty them of air.

The shell-fish of the aquatic tribe best known in this country is the *periwinkle*, vulgarly called the pin-patch,[1] which, next to the oyster and the cockle, seems most in request as a relishing article of food. These animals, as I observed, not very long since at Cromer, in Norfolk, appear to make the bladder-kelp,[2] which, at low water, may be seen there in large patches, a kind of submarine pasture, for I found them in abundance upon it at low water. As the Creator willed that the waters, whether salt or fresh, should have their peculiar inhabitants, it was requisite that each should have its appropriate food. Did all feed upon the same substance there would be a universal struggle, unless indeed, the entire variety of the submarine botanical world was done away, and one homogeneous article provided, in such quantity as to be a sufficient supply for all. But further, doubtless, different organizations and forms could not be maintained upon the same pabulum, and therefore different creatures required different articles of food, or different parts of the same article. Here was a mutual office—the numberless vegetable productions require to be kept within due limits, and therefore the functions of the aquatic animals is to maintain them in due relative proportions. Was the ocean and all its streams planted as now, and there were no animals of any description to keep in check its vegetable productions, they would all in time grow up and choke the rivers and gradually raise the bed of the ocean till there would be *no more sea.*

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[1] *Turbo litoreus.*

[2] *Fucus vesiculosus.*

Having considered the plant-devouring Trachelipods, I shall say something next upon the *carnivorous* or predaceous ones, which form the great body of large marine shells, and those which most ornament our cabinets, for to this tribe belong the Cowries,[1] Cones,[2] Mitres,[3]

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[1] *Cypræa.* [2] *Conus.* [3] *Mitra.*

Whelks,[1] Tuns,[2] Volutes,[3] Helmets,[4] Rock-shells,[5] Strombs,[6] and other conchs which exceed the general run of shells in beauty, form, and magnitude. But with regard to their habits and instincts we know little or nothing of any interest.

They are distinguished from the herbivorous ones by breathing the sea-water, for they are all submarine, by means of a siphon or tube, instead of by an aperture in the neck; in the place of maxillæ, their mouth is furnished with a retractile proboscis, with which they pierce and suck other shell-fish. The aperture of the shell is also very different, the siphon being accompanied sometimes by a channel, and sometimes by a notch at the base of the aperture.

The tribe most celebrated from ancient times, on account of the vaunted purple die which one species produced, is that constituted by the *Rock-shells*, or Linné's great genus, *Murex*, and Lamarck's canaliferous Zoophagans, called so from the long straight canal which terminates the mouth of their shells. The principal feature of this tribe, besides their long channelled beak, is the vast variety of spines, and other processes and ridges, with which their Creator has armed a great number of them; the beak and mouth of several give them no small resemblance to the heads of certain birds, thus one is called the thorny woodcock,[1] another the snipe,[2] &c.

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[1] *Buccinum.*
[2] *Dolium.*
[3] *Voluta.*
[4] *Cassis.*
[5] *Murex.*
[6] *Strombus.*

At the first blush an inquirer into the use of these spines and other arms of shell-fish, would imagine that their object is defence, yet when he is told that those which are most remarkable for them, are themselves predaceous animals; and that the herbivorous shell-fish are usually not distinguished by any thing of the kind, he seems to hesitate as to what conclusion he shall draw. It may be observed, however, that the tribe most distinguished for these arms, the rock-shells, are not so remarkable for their size as many others which live by prey, as the strombs, the helmet-shells, and the tritons, so that their armour may sometimes prevent one of these from boring their shells, and inserting its proboscis into them.

The tribe we are now considering, the rock-shells, were in high esteem from the earliest ages on account of the die that some of them afforded, and cloths died with it bore a higher price than almost any other: more than one species, however, yielded anciently a die; one, according to Bochart, a glaucous or azure colour, as he interprets it, and the other purple. But

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[1] *M. Tribulus.*

[2] *M. Haustellum.*

Tyrian purple is no longer in request. I could say much, observes the author just named, upon the finding, fishing, and method of dying of the purpura, about the price formerly enormous, nearly equalling that of pearls, a single shell, according to Aristotle, selling for a mina or about *3l.* concerning the time at which it began gradually to grow out of fashion, and at length to be wholly neglected: so that now it is never used, and no one knows the method of preparing it. In fact, the cochineal seems to have supplanted it, but it would surely be an object of great interest to re-discover the Tyrian rock-shell, as well as that which yielded the azure colour, and ascertain how far they deserved, especially the former, the high encomiums bestowed upon them, and to deck imperial shoulders. The shells are probably still in existence on the coast of Palestine. It was the custom to crush the shell as soon as taken, for if kept the animal was wont to vomit its flower, as the purple die was called by Aristotle. This great philosopher thought the purpura lived six years, as the adult animal had six whirls in its shell, and he supposed one to be formed annually. He gives a detailed history of these animals, of their congregating in the spring, and of their forming a kind of comb, like bees; he also mentions several kinds of them, that the small shells were bruised, and the animal extracted from the large ones;

that the die lies between the neck and what he denominates the poppy. It is found, by Cuvier, to be placed above the neck by the side of the stomach. Plumier relates that a shell-fish of this genus squirts out its fluid in a stream, whenever molested, which renders it probable that its object is defence.

Aristotle mentions the operculum of the purple, and also the proboscis, or tongue as he calls it, which he describes as longer than the finger, and protruded from under the operculum, with this it feeds, and with it can pierce shells, and will attack even those of its own kind; this agrees with modern observations, adding that the tongue is terminated by a sucker armed with short tentacles. Aristotle also observes, an observation confirmed likewise by modern investigators, that these animals bury themselves in the sand like the pectens. This learned naturalist also states that shell-fish at certain seasons hide themselves, snails in the winter, and the purples and whelks for a month during the dog days.

The die of the purple is mentioned in scripture as well as that of the coccus, and was used as such in the time of Moses. It is said also to be used at this time in India and America to dye small pieces of stuff, but in no place is it an important object.

Having given so long an account of the rock-shells or purples, I shall not have occasion to dilate upon any of the remaining genera, but shall merely notice a few peculiarities that some of them exhibit.

The Cowries are a tribe long known and admired for their beauty and polish, and one species[1] forms the current coin in many parts of Africa, and many Asiatic Islands. Some remarkable facts distinguish their history; from the form of their shell and of its aperture, its increment could not take place in the usual way, these animals, therefore, are furnished by their Creator with a remarkably ample mantle, the wings of which cover half the shell, and thus it is gradually thickened, and changes and variations in the colour take place that have puzzled conchologists to distinguish a species from a variety. At certain times the animal is also stated to quit its shell, and form itself a new one more appropriate to its size, a circumstance related by Aristotle of the Buccinum.[2]

Volutes are another polished tribe of shells, which are probably formed by the mantle as in the Cowries—they are particularly distinguished by having no operculum. The jet volute is viviparous, and its young when excluded are said to have shells an inch long. These probably are more exposed to enemies than the young of other shell-fish. They form an important article of food to some African nations.

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[1] *Cypræa Moneta.*

[2] Κηρυξ, Arist.

Before I close this account of these predaceous Molluscans, I must observe, that they have two distinct sexes, and consequently male and female shells. The genuine hermaphrodites are confined to the bivalves, for in the univalve hermaphrodites two individuals are necessary for re-production, and therefore those form a distinct link between the true hermaphrodites that impregnate themselves, and those that have distinct sexes. So gradual are the steps by which the Creator passes from low to high. First, animals are re-produced without sexual intercourse, as in the polypes; then the two sexes are united in one body, and suffice for their own impregnation—next follow two sexes in the same body, which cannot impregnate themselves, bringing us at last to distinct sexes, or unisexual individuals.

4. Lamarck's fifth family, the *Heteropods*, I introduce here because, being univalves, they appear to connect that tribe with the Cephalopods forming his fourth order, but which from the discovery of the animal of *Nautilus Pompilius*, so admirably described by Mr. Owen, being further removed from the other Molluscans, and the animal of the Heteropods having a proboscis and only two tentacles, seems inter-

mediate between the Zoophagan Trachelipods and the Cephalopods. They have four swimming organs. There seems a considerable affinity between this tribe and the Pteropods in these organs, which indicates a circular arrangement in the univalve Molluscans. The *Carinaria vitrea* is one of the rarest shells that is known, arising probably from its extremely fragile conch, which is nearly as transparent as glass. A model of it in wax may be seen in the British Museum. The animal is a sailor like the Argonaut, to which it comes near. It is found in the South Seas. There are two other species known, one of which frequents the Mediterranean. Some genera without shells are placed in this order by Lamarck. They swim horizontally like fishes, which circumstance, in conjunction with their fins or swimming organs, induced him to place them at the end of the Molluscans as near the fishes; several authors consider them as belonging to the *Pteropods*, to which they are certainly related.

CHAPTER X.

Functions and Instincts. Cephalopods.

WE have now taken leave of what may be called the *proper* Molluscans, including the Bivalves, and Univalves[1] of Aristotle and Linné, or the Conchifers and Molluscans of Lamarck, and are arrived at a Class remarkable, not only for their organization, form and habits, but also for their position in the animal kingdom; for in their composition they seem to include elements from both the great divisions of that kingdom: from the Vertebrates—the beak, the eye, the tongue, an organ for hearing, the crop, the gizzard, and an analogue of the spine, with several other parts enumerated by Cuvier; and from their own sub-kingdom, many of their remaining organs. We may descend to the very basis of the animal kingdom for the first draught of their nervous system, for it is discoverable in the wheel-animals in which Ehrenberg detected pharyngal ganglions and a nuchal nervous collar;[2] the sucker-bearing arms seem to have their first outline in the fresh water polypes;[1] indeed if the mouth of the cuttle-fish with its suckers, be separated from the head, leaving behind the long arms, we see immediately an analogue of a radiary, particularly of a star-fish, with its rays bearing suckers below, and its central mouth. The lamellated tentacles observed by Mr. Owen in his work, before quoted, on the animal of the Pearly Nautilus,[2] above and below the eyes, seem to lead to the antennæ of Crustaceans and Insects, and numerous Molluscan characters are obvious to every one. From these circumstances it seems evident that the Creator has placed this tribe in a station which leads to very different and distant points in the animal kingdom, and that there is scarcely any but what may recognize in it one or more of its own peculiar features—yet at the same time it exhibits many characters, both in its most extraordinary outward form and in its internal organization, that are quite peculiar and *sui generis*, of which no animal at present known exhibits the slightest traces. To mention only its muscular apparatus adapted to its unparalleled form; its system of circulation, carried on in the first Order by three distinct organs instead of one heart; and the wonderful complication of their tentacles, of the nerves that move them, and the vascular system that animates them.

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[1] Διθυρα. Μονοθυρα.

[2] *Ganglia nervea pharyngea. Annulus nerveus nuchalis.* Ehren.

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[1] *Hydra.*

[2] *Nautilus Pompilius.*

This singular Class, which Cuvier denominated *Cephalopods*, or having their feet attached to their head, appears to follow very naturally the Trachelipods and Heteropods, lately described, which have not only eyes furnished with iris and pupil, but also distinct sexes, and are of predaceous habits, all characters which they possess in common with the Cephalopods or Cuttle-fish. There is, however, an animal amongst the naked Gastropods—called by the ancients, from its tentacles representing the ears of a hare, the sea-hare,[1] a name it still bears in Italy, which Linné named *Laplysia*, in which he was followed by Lamarck, but modern writers after Gmelin have called it *Aplysia*, a name used by Aristotle for a very different animal, a kind of sponge,[2] and, therefore, improperly applied—this animal has many characters that are found in some of the Cephalopods, particularly in its circulating and nervous systems; in having internal solid parts, and in discolouring the water with an inky fluid, so that there seems also a connection between this genus and the Cephalopods amounting to something more than a mere analogical resemblance.

Mr. Owen has divided this Class into two

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[1] *Lepus marinus*, Plin.

[2] *Hist. An.* l. v. c. 16.

Orders, from the composition of their respiratory organs, namely, those that have two branchiæ,[1] or gills, and those that have four.[2] The first includes those that have no shell, and the second those that have one. The last is further divisible into those whose shell has many chambers, as the *Nautilus*, and those where it has only one, as the *Argonaut*, or paper nautilus.

To the first of these Orders belongs the *cuttle-fish*,[3] one of the most wonderful works of the Creator. Its mouth is surrounded by eight long fleshy arms, or rather legs, somewhat conical in shape, and acute at the end, moved by innumerable nerves, furnished from numerous ganglions: these legs can bend in every direction with the utmost vigour and activity, their surface is furnished with many suckers, by which they can fix themselves strongly to any thing they wish to lay hold of, and by means of which, like the star-fish,[4] they can move from place to place. When this animal walks, in this resembling also the star-fish and sea-urchin,[5] it moves with its head and mouth downwards and its body elevated. It swims also and seizes its prey by means of these organs: besides these arms or legs, for they perform the functions of both, there is a pair of long organs, one on each side, having their origin between the first and second pair of legs, which are incrassated at the end, where, also, they are furnished with many suckers. Cuvier supposes they use these as anchors to maintain them in their station during tempests, and as prehensile instruments, by which they can seize their prey at a distance. In the centre of the legs is the mouth, surrounded by a tubular membranous lip, including a beak, consisting of two mandibles, like that of a paroquet; these mandibles or jaws are crooked, and the upper one fits into the lower as a sliding lid into a box. With these redoubtable jaws the cuttle-fish devours fishes, crustaceans and even shell-fish, which receive a further trituration in its muscular crop and its gizzard. By means of the suckers on their legs and arms, they lay such fast hold of their prey as to deprive them of all power of motion; thus they master individuals much larger than themselves. The hard and often spinose crust of crabs or lobsters cannot withstand the action of their trenchant jaws, and they do not fear the gripe of their claws. Their large eyes, which resemble those of vertebrated animals, by their look of ferocity, are enough to create an alarm in the animals they pursue, and are said to see in the night as well as the day. So that although they are not like Pontoppidans Kraken—the notion of which is thought to have been taken from a large cuttle-fish—half a league in circumference, so as to be mistaken for floating islands, yet they are really as tremendous animals, their size considered, as any that Providence has commissioned to keep within due limits the populace of the waters.

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[1] *Dibranchiata.*

[2] *Tetrabranchiata.*

[3] *Sepia.*

[4] See above, p. 201.

[5] Ibid, p. 212.

One of their most remarkable and unique features, is the manner in which circulation takes place in them. They have *three* hearts; the principal one, seated in the middle, sends the blood through the arteries: the blood returns by a *vena cava*, which dividing into two branches, carries it to the two lateral hearts, each of which sends it to the gills for oxygenation, whence it returns again by the intermediate heart.

The *Octopus*, called by the French writers the *Poulpe*, probably a contraction of polype, differs from the common cuttle-fish, having neither the arms nor long tentacles of that animal, and instead of the large heavy bone has only two small cartilages. This different structure is rendered necessary by the difference in their habits. The body of the octopus is small, and it has legs sometimes a foot and a half in length, with about two hundred and forty suckers on each leg, arranged, except near the mouth, in a double series; so that it walks with ease. They are often out of the water, and frequent rough places, are excellent swimmers, and move rapidly in the water with their head behind. The cuttle-fish, whose legs are short and body heavy, prefer the bottom, and do not attempt to swim, for which they are not well fitted. Providence has, therefore, given them their long arms to compensate for the shortness of their legs.

A remarkable peculiarity distinguishes these animals. They are furnished with an organ which secretes a black fluid, with which they can produce an obscurity in the water that surrounds them, on any appearance of danger, or to conceal themselves from their prey. The Chinese are said to use it in making the ink that bears the name of their country; something similar, but not so black, is prepared from it in Italy; and Cuvier used it to colour the plates for his memoir on these animals.

The second order of cephalopods, or at least the pearly nautilus, differs in several respects from those which constitute the first, and which I have just described, approaching much nearer to the Molluscans. The most striking approximation, and which first catches the eye of the examiner is its shell, which, though its spiral convolutions are not externally visible, exhibits a general resemblance to a univalve shell. To a person who had the opportunity of witnessing the motions of the animal that inhabits it, the first thing that would strike him, would be the means by which it progressed upon the bed of the sea, he would see no motion produced by the action of tentacular legs furnished with suckers, like those of the cuttle-fish, but instead of it, by a single expansive organ, exhibiting considerable resemblance to the foot of a snail. This organ, Mr. Owen, led by the nervous system, regards as surmounting the head and as its principal instrument for locomotion. The oral organs of this animal are much more numerous and complicated than those of the cuttle-fish, and are furnished with no suckers. Its tentacles are retractile within four processes, each pierced by twelve canals protruding an equal number of these organs, so that in all there are forty-eight. In fact, the whole oral apparatus, for the full description of which I must refer the reader to Mr. Owen's excellent tract, except the mandibles and the lip, is formed upon a plan different from that of the cuttle-fish, as likewise from that of the carnivorous trachelipod Molluscans, and indicates very different modes of entrapping and catching their prey.

The eye, also, Mr. Owen states to be reduced to the simplest condition that the organ of vision can assume, without departing altogether from the type of the higher classes, so that it seems not far removed from that of the proper Molluscans. In this animal there is only a single heart, the branchial ones being wanting.

There is one circumstance which proves this cephalopod to belong to this shell, and not to be a parasitic animal as that of the argonaut has been supposed to be—it is this, though the whole body appears to reside in the last and largest concameration of the shell, yet there is a small tubular tail-like process which enters the siphon, but which unfortunately was mutilated, only a small piece being left, but enough to shew that the animal had power over the whole shell by means of this organ, hence it follows that a Cephalopod is the animal that forms the shell of the nautilus, and its natural inhabitant, which goes a great way towards settling the controversy concerning the real animal of the argonaut, and amounts almost to a demonstration that the celebrated sailor that uses it as a boat, and scuds gaily in it over the ocean, is no pirate that has murdered its natural owner, but sails in a skiff of his own building.

The only circumstance that now leaves any doubt in the mind of the inquirer, is the very different nature of the cephalopod of the argonaut and the nautilus, the former appearing to be nearly related to the octopus or poulpe, and belonging to the genus *Ocythöe* of Rafinesque. In this genus the tentacular legs or arms are similar to those of the poulpes, planted on the inner side with a double series of sessile suckers, the second pair having a membranous dilatation at their apex,[1] which the animal is supposed to use as a sail when it moves on the surface of the sea. Some naturalists deny that this animal ever uses these organs for sailing or rowing, but Bosc expressly asserts, and I am not aware that there is any reason to doubt his veracity, that he has seen hundreds of the argonauts rowing over the surface of the sea, in calm days, at so small a distance from the vessel in which he was sailing, that though he could not catch one, he could observe all their manœuvres; he further says, that they employ their dilated tentacle sometimes as a sail and sometimes as an oar.

When we consider how many instances are upon record of Molluscans being fitted with organs that enable them to catch the wind and sail on the surface of the sea,[2] there is nothing contradictory either to analogy or probability that the argonaut should do the same, especially when we consider how universally this idea has prevailed, from the time, at least, of Pliny and Oppian, both of whom describe its sails with sufficient accuracy. Aristotle also speaks of his polype, which is evidently a cephalopod, as a sailor by nature—he says, that when it rises from the deep it is in a subverted shell, rendering that action more easy and keeping the shell empty, but that when arrived at the surface it reverses it; that it spreads its sail to the wind, and when that blows, letting down its two cirri, one on each side, uses them to steer with.

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[1] See *Zool. Journ.* n. xiii, t. iii.

[2] See above, p. 263.

Upon comparing the animal of the nautilus with that of the argonaut, it appears evident, though the gills of the latter seem not to have been examined, that they belong to different Orders, at least, every probability rests on that side; yet every thing speaks the relationship of the latter to the octopus, and therefore they would properly form a section of the *dibranchiata* of Mr. Owen. In fact, the oral organs of the former are so widely different from those of the Order just mentioned, that one would almost expect another to connect them. This probably lies dormant amongst the fossil ammonites, the shells of many of which, though consisting of many chambers, are evidently intermediate between the nautilus and argonaut.

We must next inquire what was the object of Him, who does nothing but with a view to some useful, though not always evident, end, in producing these miniature monsters of the deep, so wonderfully organized and so unlike every other tribe of animals, in his creation, and yet containing in them, as we have seen, as it were, the elements, whether we ascend or descend, of all the rest. It appears from the united testimony of almost every writer that has noticed them, that they have it in charge to keep within due limits, a tribe of animals, almost equally destructive with themselves, and which are armed also with weapons of offence, apparently equally terrific to their prey. It will be readily perceived that I am speaking of the *Crustaceans*, and of the formidable pincers with which they seize their prey. It must be a curious spectacle to see one of the larger poulpes attack a lobster; at first sight, we should think the latter most likely to master his assailant, covered as he is with a hard crust, and using adroitly his powerful forceps, we should feel sure that the cuttle-fish, with his soft body and oral organs equally soft, stood no chance against such an antagonist. But He who gave him his commission, has fitted him for the execution of it, his soft tentacular organs will bend in every direction, and the numerous suckers wherewith they are planted, by pumping out the medium that forms the atmosphere of marine animals, produce such a pressure where-ever they are fixed, that, struggle as it may, it cannot disengage itself from the grasp of its assailant; and, by their flexibility, these organs can imitate the fishermen, and tie together the two pieces of the forceps, so that it cannot bite;

thus, at last, it is brought within the action of the powerful beak of the cuttle-fish, which soon makes its way through its crust, and devours it shell and all. Even when at a distance, by means of its long arms, the cuttle-fish can lay hold of it and drag it towards it; and the poulpe, which has not these arms, makes up for it by having longer legs.

The argonaut probably uses similar means to master its prey, and finds some defence in its shell, but the nautilus has a still stronger castle, which it may be supposed defies the bite of the Crustacean; its oral organs are calculated for closer combat, but the tentacles appear less adapted for holding fast their prey, not being visibly furnished with suckers, but what they want in power is made up in numbers, since in lieu of eight or ten tentacular organs, they have nearly a hundred. So diversified are the ways and instruments by which infinite WISDOM, POWER, and GOODNESS enables its creatures to fulfil the ends for which he created them: and so an equilibrium is maintained in every part of creation.

The fossil species are mostly called by one name, *Ammonites*, as if they were the horns of the Egyptian Jupiter, and which, if any of them are now in existence, probably frequent the depths of ocean, and do not, like the argonaut or nautilus, visit its surface, to tell an admiring world, that God has created such wonderful beings. Specimens have been found of the enormous diameter of six feet. Though the sculpture of many of these great cephalopods gives reason to think that they may be intermediate between the argonaut and nautilus, yet the convolutions and external form of their conchs gives them no small resemblance to a genus of snails,[1] the species of which are often found in fresh waters, except that in this the shell is more concave on one side than the other. The genus *Spirula*, the animal of which appears also to be a Cephalopod,[2] seems to exhibit the first tendency to this form.

Amidst all this variety of Molluscous animals, exhibiting such diversity in their structure and organization, in their habits, food, modes of life, and stations, one great object seems attained by their creation especially, the production of calcareous matter. Even the shells of terrestrial testaceans, if we consider the vast numbers that every year perish, must add in no trifling degree to the quantity of that matter on the earth, and probably make up for the continual waste or employment of it, so as to maintain the necessary equilibrium; but in the ocean, the quantity added to that produced by corallines, must be exceedingly great, even in lakes beds are formed of the deposits of the shell-fish inhabiting them, how much more gigantic must they be in the ocean, this will be evident from the superior number and size of the oceanic shells compared with the minute species, the *Limnea*, *Planorbis*, &c. that inhabit our lakes and pools. Thus, as reefs and islands are formed by the coral animals, the bed of the ocean may be elevated by the shells of dead testaceous ones. That eye which is never closed, that thought which is never intermitted, that power which never rests, but, engaged in incessant action, and employing infinite hosts of under-agents to effect his purposes, sees and provides for the wants of the whole creation: the plant absorbs from the soil, the animal after devouring the plant, or the plant-fed creature, returns to the earth what the plant had absorbed, and so maintains the proper equilibrium; He who numbers the hairs of our head, numbers the workmen that he employs, employing them only in such proportions so distributed, as may best accomplish His purposes.

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[1] *Planorbis.*

[2] PLATE VII. FIG. 2.

CHAPTER XI.

Functions and Instincts. Worms.

WE are now at length, after long wanderings, arrived, if I may so speak, at the limits of the Molluscan territory, and, having visited the capital, seem now to be upon the confines of the higher hemisphere of the animal kingdom, the inhabitants of which are distinguished by having their whole frame built upon a vertebral column, inclosing a medullary chord, and terminating, at its upper extremity, in a skull containing a developed brain.

But though we seem arrived at the confines of this higher order of animals, there are still many, and some superior to the most perfect of the Molluscans, in the entirety of their nervous system, and the habits and instincts which they manifest, to which we have not yet paid the attention that they merit. These animals are particularly distinguished from the preceding Classes, by the *appearance*, or *actual existence* of *segments* or joints in their bodies, especially in their legs, of what may be called an annular structure. They are divided into two great tribes, which, from this circumstance, have been called *Annelidans*, and *Annulosans*, and the last, with more propriety, *Condylopes*.

There is one tribe, however, amongst the Radiaries, as we have seen, that shews some slight traces of insection, I allude to the star-fish and sea-urchins, forming the main body of Lamarck's Order of Echinoderms. If we examine the former, we find them marked out into areas, and in the latter, as I have before stated at large, the whole shell consists of numerous pieces united by different kinds of sutures.

Before I call the reader's attention to the two tribes lately mentioned, exhibiting the appearance or reality of insection, I must notice an anomalous tribe of animals, whose real station has not been satisfactorily made out. I am speaking of the *Entozoa* or Intestinal Worms. This Class, as Mr. W. S. Mac Leay has remarked, consists of animals differing widely in their organization, some having a regular nervous system formed by a medullary collar sending forth two threads, while others have no distinct organs of sense.

Lamarck places this Class between the *Tunicaries* and *Insects*, and Cuvier, amongst his *Zoophytes*, between the *Gelatines* and *Echinoderms*. Mr. Mac Leay has divided it into two classes, placing one, consisting of the Parenchymatous intestinal worms of Cuvier, between the *Infusories* and *Polypes*, and the *Cavitaries* of that author, amongst the *Annulosans* or *Condylopes*. Dr. Von Baer is of opinion that these Entozoa, or worms, reducible to no common type of organization, inhabiting various animals in various parts of their body, together with the Infusories—and others might be added—should be banished from a natural arrangement of animals. He seems also to think, in which I feel disposed to agree with him, that the leading types of animal organization are to be found in its lowest grades.[1] As I formerly observed with respect to the Infusories[2]—these appear to be the basis on which God has built the animal kingdom. As some of the species appear connected with the *Annelidans*, I have introduced the Class here, but not as having formed any settled opinion as to its proper division and legitimate station.

The majority of this Class are, what their name imparts, *intestinal worms*, or parasites, that have their station *within* the body of other animals. Some of them, however, do not answer this description, as they are found only amongst aquatic vegetables; of this kind is a little tribe, which Linné arranged with the leeches,[3] to which they approach by the flukes.[4] The *Planaria*, in some respects, partakes more of the nature of a polype than of any other animal. Draparnaud, who paid particular attention to them, says that when young they have only two eyes, and acquire two more when adult. The head has no mouth; beyond the middle of the body, and on its under side, is a single orifice which serves for mouth, anus, and nostrils. This orifice answers to a long sac, which is the intestinal tube; from it sometimes issues a white tubular organ, which he regards as respiratory; this organ is doubtless the same with the retractile trumpet-shaped proboscis, issuing from a circular aperture in the middle of the abdomen, mentioned by Dr. Johnson in his interesting paper on these animals in the Philosophical Transactions, which he supposes to be a kind of mouth, when extended, equalling in length the animal itself.[1] This remarkable organ was also noticed by Müller and Mr. Dalyell. The circumstance of its receiving and extruding its aliment and respiring at the same orifice, is a clear approximation to the polype. A further confirmation of this is the power this animal possesses of spontaneously dividing itself for the purpose of reproduction. M. Draparnaud—after remarking that the species he described, which he calls *P. tentaculata*, and which is probably synonymous with that particularly noticed by Dr. Johnson under the name of

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[1] See *Zool. Journ.* July—October, 1828, 260.

[2] See above, p. 148.

[3] *Hirudo.*

[4] *Fasciola. Distoma.*

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[1] Philos. Trans. 1825. i. 254. *t*. xvi. *f*. 10.

P. cornuta, is oviparous in the spring and gemmiparous in the autumn—observes, that, in the latter season, it divides itself spontaneously and transversely into two parts above the abdominal orifice, and at the end of ten days each of these parts has acquired the head or the tail that it wanted. He has divided individuals into many transverse pieces and two longitudinal ones, and every piece, in due time, completed itself. It formed eyes, an intestinal tube, and other necessary organs.

Mr. Dalyell and Dr. Johnson subsequently made similar observations, and by dividing the head had succeeded in producing an animal with two heads; the latter, from the result of several observations, found that each individual, upon an average, might, by spontaneous self-division, produce ten, and this when under constraint; if at liberty, and in their natural situation, we may conjecture that their reproductive powers might be carried much higher. Dr. Johnson divided one into three equal portions, when the head speedily acquired a new body and tail; the tail, a new body and head; and the middle piece a new head and tail.

From this whole statement it is evident that these pseudo-leeches, to say the least, their substance considered, tend towards the polypes, and possess the same reviviscent powers. In several characters, which I shall notice hereafter, they also agree with the Annelidans. Draparnaud, from the approximation of the points on the head of *P. cornuta*, to the tentacles of *Lymnea*, thinks that they form a link between the Molluscans and the Worms. Reproductive powers have certainly been observed in the former, but only in the reproduction of mutilated organs, for a snail or slug cut in pieces, would not form so many individual animals. Bonnet has given an account of reproductive powers in one of the *Hispid Worms*[1] of Lamarck, supposed by Gmelin to be the *Nais barbata* of Müller, and in a species of fresh water worm belonging to the Annelidans, which, if I may so speak, grows from cuttings, and like the *Planariæ*, can produce two heads. These last are probably not far removed from the flukes,[2] though their station is so different. Whether they live on animal or vegetable matter is not certainly ascertained; to look at their proboscis it seems rather calculated to fix them as a sucker, to some animal, and so to derive their nutriment from it, like their analogue, the leech, especially as the marine species are supposed to be carnivorous.

Their wonderful reproductive powers appear to be given them by a kind Providence to prevent their total annihilation; at least, it is stated, that at certain periods of the year, their numbers are so reduced, that where thousands were seen in summer, in spring scarcely one has survived. Their substance is so soft and gelatinous, that they are easily destroyed; to compensate this, they are gifted with the extraordinary powers of reproduction above described. God hath so tempered his sentient works, that seeming defects, in one respect, are compensated by redundance in another.

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[1] *Vers hispides.*

[2] *Fasciola.*

Having made these observations upon animals of this class, that do *not* infest man or beast internally, I next turn to those whose office is, in spite of all his care, to make the Lord of the Creation, as well as the whole animal kingdom, not only their constant abode, but also their food. More than *twenty* of these pestiferous creatures, that attack man, have been enumerated; some penetrate into the very seat of thought;[1] others disturb his bile;[2] others circulate with the blood in his veins;[3] others, again, are seated in his kidneys;[4] others in his muscles;[5] the guinea worm[6] in his cellular tissue: the ovaries of females are infested by another;[7] the tape-worms extend themselves, joint by joint, to an enormous length in his intestines;[8] some

[1] *Echinococcus Hominis.*

[2] *Fasciola hepatica.*

[3] *Linguatula Venarum.*

[4] *Strongylus gigas.*

[5] *Hydatigera cellulosa.*

[6] *Filaria medinensis.*

[7] *Linguatula pinguicula.*

[8] *Tænia solium*, and *Botryocephalus Hominis.*

select the large intestine;[1] and others the small ones;[2] some even attack infants, and them only.[3] Such are the ills that flesh is heir to from these our internal assailants and devourers.—The recital is really enough to cause our hair to stand on end. No one can believe that all these instruments of punishment were at work in the first pair when they came from the hands of their Maker, and nothing, except *death*, can prove with a greater strength of evidence, that he is fallen from his original state of integrity and favour with God, than such an army of scourges set in array against him. I shall enlarge a little upon a few of them, and then bid adieu to the disgusting subject.

There are few people, that have not heard of the *fluke*, or animal resembling a flat fish, and which really has been mistaken for one, often found in the liver of diseased sheep, and sometimes also in the human gall-bladder and bile-vessels. The eyes of these animals are very prominent, and set in a cartilaginous ring, seeming to exhibit both iris and pupil; they are both planted in the upper side of the head, like those of the fish[4] they resemble. Like the leech, the fluke has two orifices—the first in a tubular prolongation of the head, and the other underneath in the abdomen, but distant from the tail. By these they fix themselves, living by suction; they sometimes produce fatal effects upon sheep. When only in small numbers, they, doubtless, as well as the rest of the Class, answer some good end; it is solely when they become too numerous that they occasion fatal diseases. Leeuwenhoek found 870 in one liver, and in others only ten or twelve. He says they occur in many kinds of quadrupeds, as stags, wild boars, and calves. He seems quite at a loss to account for their introduction into the livers of these animals, but concludes that, like the leech, their native element is water, and their eggs, swallowed by cattle when they drink, so find their way into the liver. This of course is all conjecture. Providence, who assigned to them their office, has also directed them to their station, but from whence or by what route we do not know certainly at present. A friend of mine who has kept a flock for many years, has observed that whenever they were turned into moist meadows in wet seasons, they suffered greatly from these animals; but that in the same situation, in a dry one, they were not affected.

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[1] *Trichocephalus Hominis.*
[2] *Ascaris lumbricoides.*
[3] *Oxyurus Vermicularis.*
[4] Leeuwen: *Arcan. Nat.* E. Tr. *t. f.* H K. i. K.

The most celebrated of all the intestinal animals, are the Tape-worms, of which *five* species have been ascertained to inhabit man, besides whom quadrupeds, birds, reptiles and fishes are equally their victims. These are now divided into two genera, the common[1] and the grape-headed tapeworms.[2] The former is the most common in England,[3] but the latter[4] seems the most gigantic of any. Sir A. Carlisle, who has a most excellent paper upon the former, in the second volume of the Linnean Transactions, says that he has met with them from less than six feet long and consisting only of fifty joints, to thirty feet long with four hundred joints. But these are nothing compared with others of the latter observed by continental writers. Bonnet mentions them as sometimes extending to the length of thirty ells, probably meaning French ells, or one hundred and twenty-five feet, and Boerhaave, one that greatly exceeded that length.

These animals differ little from each other, but in the common tape-worm, the head which has a circular orifice or mouth at its extremity surrounded by a number of rays of a fibrous texture, and probably serving to fix the mouth, has on each side two small suckers which doubtless attach the head more strongly. The mouth, before spoken of, is continued by a short duct into two canals, which pass round every joint of the animal's body conveying its aliment, and sending a transverse canal along its bottom which connects the two lateral ones. Sir Anthony injected upwards of three feet of these canals by a single push with a small syringe, but he could not make it pass upwards beyond two joints which seemed to indicate the existence of valves opening only in one direction. He says there is no anal orifice, but other authors expressly mention one, and it is not easy to conceive, if the last has no orifice, how the joints can increase in number and remain concatenated. The body is composed of a vast number of joints, each having an organ whereby it attaches itself: those nearest the head are always small and they enlarge gradually as they recede from it. The extremity of the body terminates in a small semi-circular piece.

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[1] *Tænia.*
[2] *Botryocephalus.* PLATE I. B. FIG. 3.
[3] *Tænia solium.*
[4] *Botryocephalus latus.*

Sir Anthony suspects that the several joints of the tape-worm are separate animals. This is an old opinion and has been adopted by several zoologists, but Bonnet seems to have proved, that however extended, the tape-worm is only a single animal. Whilst a living head remains attached to some joints, this creature maintains its station and keeps augmenting their number, but when any are broken off, they appear not to form new heads, as Sir Anthony supposes, but die and are expelled from the body. Their nutriment is probably derived from the gastric, pancreatic, and other juices which perpetually flow into the stomach and intestines of the animals they infest; and they employ the tentacular rays as a mean of irritation to determine a greater secretion of these fluids.

It would be an endless labour to expatiate in this vast field where the rest of the animal kingdom is concerned, amidst therefore the various and strange forms that are destined to this office, I shall select only a few, beginning with one that affects one of the most valuable of our animal possessions, I mean the *Hydatids*,[1] which particularly and often fatally affect our flocks of sheep, not indeed that they are confined to them, for they are found also in swine, deer, and oxen, and even in man himself.

These animals resemble the tape-worm in their oral organs, but their body, especially posteriorly, is vesicular. The lymphatic vesicles are what medical men call hydatids; they are found usually in the brain and in the liver of these animals. Their size varies according to the species, some are as big as the fist, and one was shewn to the School of Medicine in Paris as big as a man's head. Their shape varies, but generally is somewhat spheroidal, their substance is composed of membranes one on another more or less thick, and formed of circular fibres visible only under a lens; they are half-filled with transparent lymph. They exhibit a peristaltic motion which is often very lively.

Three species more particularly annoy our sheep. The cerebral hydatid,[2] which finds its way into the brain of these poor animals and occasions the vertigo; and the vervecine[1] and ovine hydatids,[2] which penetrate into their lungs and liver and occasion the rot. It is usually discovered when a sheep is infested by the former of these pests by its turning often and briskly its head on one side; when it runs very quick, and suddenly stops without any apparent cause; in a word, when it appears almost deranged. Though the progress of the disease they produce is slow, it is generally fatal. Five hundred have been counted in the head of a single sheep. The ravages, however, produced by this hydatid are nothing to those occasioned by the other two, which attack the lungs and liver and cause the rot, by which, in some years, thousands perish.

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[1] *Hydatis.*

[2] *H. cerebralis.*

Some worms are remarkable for their very singular forms or station. One that attaches itself to the gills of the bream, looks like a double animal,[3] and a kind of fluke,[4] in great numbers infests the ball of the eyes of the perch.[5]

Though at first view the animals of which I have in the present chapter given some account seem to be altogether punitive, and intended as scourges of sinful man both in his own person and in his property, and their great object is hastening the execution of the sublapsarian sentence of death, yet this evil is not unmixed with good. Though fearful and hurtful to individuals, yet it promotes the general welfare by helping to reduce within due limits the numbers of man and beast. Besides, with regard to the Lord of the Creation, these things are trials that exercise his patience and other virtues, or tend to produce his reformation, and finally to secure to him an entrance into an immutable and eternal state of felicity, when that of probation is at an end, so that the gates of Death may be to him the gates of PEACE and REST.

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[1] *H. vervecina.* [2] *H. ovilla.*

[3] *Diplozoon paradoxum.* PLATE I. B. FIG. 4.

[4] *Diplostomum volvens.* Ibid, FIG. 5.

[5] Ibid, FIG. 6.

CHAPTER XII.

Functions and Instincts. Annelidans.

THE animals we have just been considering form an almost insulated group, so that it seems not easy to say to what tribe they are most nearly related, but the soft Pseudo-leeches, as was observed above, especially those that have rudimental tentacles, seem to tend somewhat towards the molluscan tribes; they exhibit considerable resemblance to the blood-suckers or true leeches, and like them have an instrument of suction, though employed, perhaps, in extracting the sap or the blood of plants, and at the same time, in many respects, as we have lately seen, they approach the polypes.

The Flukes, likewise, appear to have some characters in common with the leech,[1] so that a passage is open from the intestinal worms towards the *Annelidans*, some of which, as the earth-worm, occasionally become intestinal, and several are possessed of reproductive powers almost as great as those of the pseudo-leech, or the polype. I shall therefore next, in taking my departure from the worms, bend my steps to the animals just mentioned, which formerly bore the same general denomination.

They are called Annelidans, I suppose, because they appear to be divided into little rings, or else to have annular folds, and are soft vermiform animals, some naked, others inhabiting tubes, in some simply membranous, in others covered with agglutinated particles of sand, and in others formed, like those of the Molluscans, of shelly matter. Some have neither head, eyes, nor antennæ, while others are gifted with all these organs; instead of jointed legs, their locomotions are accomplished by means of fleshy bristle-bearing retractile protuberances or spurious legs disposed in lateral rows. Their mouth is terminal but not formed on one type; in some it is simple, orbicular or labiated; in others it consists of a proboscis often having maxillæ. They have a knotty spinal marrow, in this being superior to the Molluscans and approaching the Condylopes. They have red blood, and their circulation is by arteries and veins, but they have no special organ for the maintenance of the systole and diastole, their Creator not having given them a heart, but where the veins and the arteries meet, there is an enlargement, and the systole and diastole is more visible, as Cuvier remarks, than in the rest of the system, these enlargements therefore seem to represent a heart.

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[1] See above, p. 325.

Savigny, in the third part of his *Systême des Animaux sans Vertèbres* divides them into five Orders, of which he gives only the characters of the four first, intending to publish, in a supplement, his account of the fifth; these Orders he arranges in two Divisions—the first including those that have bristles for locomotion, and the second those that have them not.

1. His *first* Order he denominates *Nereideans*,[1] and characterizes them as having legs provided with retractile subulate bristles, *without* claws; a distinct head with eyes and antennæ; a pro-

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[1] *Nereideæ.*

boscis that can be protruded, generally armed with maxillæ.

2. The *second* he names *Serpuleans,* these add to the legs of the former retractile bristles, *with* claws; they have no head furnished with eyes and antennæ, and no proboscis.[1]

3. The *third* he names *Lumbricinans;* these have no projecting legs; but are furnished with bristles seldom retractile; they have no head with eyes and antennæ, and no maxillæ.

4. His *fourth* Order he names *Hirudineans.* They have a prehensile cavity, or sucker, at each extremity, and eyes.[2]

5. In his *fifth* Order he intends to comprehend those Annelidans that have neither bristles nor prehensile cavities, but his account of this has not been published.

He begins with the most perfect of the Annelidans, but viewing them in connection with the worms I must reverse the order, and instead of descending ascend, which will bring me ultimately into connection with the more distinctly jointed animals the Condylopes.

1. The Order of *Hirudineans* includes animals that are of the first importance, as well as some that are fearfully annoying, to mankind. The common leech[3] has long been so much in request

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[1] *Serpuleæ.* [2] *Lumbricinæ and Hirudineæ.*

[3] *Hirudo medicinalis,* L. (*Sanguisuga,* Sav.)

with medical men, on account of the facility with which it can be applied to any part of the body where bleeding is required, that they are now become scarce in our own waters, and consequently dear, so that large numbers are imported from the Continent.

Providence has gifted these animals with a sucker on the underside at each extremity of their body, by which their locomotions are performed, and by means of the anterior one they fix themselves to any animal that comes in their way. We see therefore in them, though on a larger scale, some approximation to the locomotive and prehensile organs of some of the Cephalopods, and prior to them, of the Stelleridans and Echinidans,[1] which likewise move and fix themselves by suckers. The mouth is situated in the cavity of the oral sucker, it is triangular and armed with three sharp teeth disposed longitudinally in a triangle, two being lateral and one intermediate, and higher up. These teeth are sharp enough to pierce not only the human skin, but even the hide of an ox, and have their edge armed with two rows of very minute teeth; at the bottom of the mouth is the organ of suction which imbibes the blood flowing from the wound made by the teeth. These animals inhabit fresh waters, in which they swim like eels with a vermicular motion. In moving on a solid body, they first fix themselves by their *anal* sucker, which is larger than the *oral*, and then by means of their annular structure, extend themselves forwards, when they fix their mouth, detach their anal sucker, and thus fixing themselves alternately by each proceed with considerable rapidity. They are hermaphrodites, and bring forth their young alive. When in their native waters they suck any animal that comes in their way, even those with white blood, as the larvæ of insects, worms, and the like.

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[1] See above, p. 306, 201, 205.

Herodotus relates that the crocodile, in consequence of its frequenting the water so much, has the inside of its mouth infested by leeches, which a little bird, named the *trochilus*, enters and devours, without receiving any injury from the monster. Geoffroy St. Hilaire asserts that no leeches are found in the Nile, and therefore supposes the *Bdellæ* of the father of history were not leeches but mosquitoes. But Savigny has described a leech under the name of *Bdella nilotica*[1] which he regards as synonymous with the leech of Herodotus. Bosc mentions one which was found in the stagnant waters in Egypt, when not inflated as small as a horse hair, which very much annoyed the

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[1] Plate VIII. Fig. 3.

French soldiers, attacking them in nearly the same way; when they drank, fastening itself to their *throat*, and occasioning hemorrhages and other serious accidents.

Mr. Madox, in his *Excursions in the Holy Land, Egypt*, &c., states that he had frequently seen, on the banks of the Nile, a bird about the size of a dove, or rather larger, of handsome plumage, and making a twittering noise when on the wing. It had a peculiar motion of the head, as if nodding to some one near it, at the same time turning itself to the right and left, and making its congé twice or thrice before its departure. This bird, he was told, was called *Sucksaque*, and that tradition had assigned to it the habit of entering the mouth of the crocodile, when basking in the sun, on a sand bank, for the purpose of picking what might be adhering to its teeth: which being done, upon a hint from the bird, the reptile opens his mouth and permits it to fly away.[1]

This seems evidently the *Trochilus* of Herodotus, above alluded to, as clearing the mouth of the crocodile from the leeches. Aristotle, in more than one place of his *History of Animals*, mentions such a bird, and a similar tradition concerning it, with that of Mr. Madox. "The Trochilus flying into the yawning mouth of the crocodile cleanses his teeth, and thus is provided with food. The latter, sensible of the benefit, suffers it to depart uninjured."[1] In another place,[2] he seems to speak of it as an aquatic bird, yet afterwards he describes it as frequenting shrubberies and subterranean places.[3] Whether this animal really attends thus upon the crocodile has not been ascertained, but it would be singular that such a tradition should have maintained its ground so long without any foundation.

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[1] *Excursions*, &c. i. 408.

As a further proof that the *Bdella* of the father of history is a true *leech*, and not a mosquito,—as M. Geoffroy St. Hilaire, from the meaning of its primitive,[4] would interpret the word,—it may be observed that Aristotle compares the Bdella to an earth-worm,[5] and describes its peculiar motion; and in Hesychius it is said to be a kind of *Scolex* or worm; Theocritus also alludes to its blood-sucking propensities.[6]

That leeches infest the aquatic Saurians is further evident from a letter received by Mr. R. Taylor, and very kindly communicated by him to me, from a friend at Calcutta, Mr. W. C. Hurry, who having observed that the fauces of the gigantic crane[7] were generally very full of leeches, determined to examine the crocodile; and upon a large alligator he found a small red species, of which he sent specimens. A friend of mine, Mr. Martin, of Islington, observed also that the alligators of Pulo Penang were infested, as he thought, by an animal of this kind, called by the natives its louse.

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[1] *Hist. An.* l. ix. c. 6.

[2] *Ibid.* l. viii. c. 3.

[3] *Ibid.* l. ix. c. 11.

[4] Them. Βδελλω, to suck.

[5] *De incessu animal.* c. 9.

[6] *Idyll.* ii. line 55, he calls it *Λιμνατις* Βδελλα.

[7] *Ciconia Argala?*

The Trochilus of Aristotle, Mr. Stanley states to Mr. Taylor, is the Egyptian Plover;[1] who further observes that the Green Tody[2] is also related to cleanse the mouths of the alligators in the West Indies, from the gnats and flies that stick, in great abundance, in the glutinous matter they contain.

But there is a terrestrial kind of leech found in the island of Ceylon, which appears to be a greater pest than any other species of the genus, and one of the greatest scourges of that fine island. They infest, in immense numbers, the mountains, woods, and swampy grounds, particularly in the rainy season. They are oftener seen on leaves and stones than in the waters. The largest are about half an inch long when at rest. Their colour varies from brown to light brown, with three longitudinal yellow lines. They are semi-transparent, and when fully extended are like a fine chord, sharp at the extremity, and easily thread any aperture, so that they can penetrate through the light clothing worn in that climate, rendering it impossible, at that season, to pass through the woods without being covered with blood, Dr. Davy counted fifty on the same person; no sooner does any individual stop, than, as if they saw or scented him, they crowd towards him from all quarters. From their immense numbers, activity, and thirst of blood, they are the great pest of travellers in the interior. Percival says that the Dutch, in their march into the interior, at different times, lost several of their men from their attack. Other animals besides man suffer dreadfully from them, and horses in particular are rendered so restive, when they fasten upon them, as to be quite unmanageable and unsafe to ride. The only way to prevent their attack, is to cover the skin completely.

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[1] *Charadrius Ægyptius.*

[2] *Todus viridis.*

The office devolved upon the present tribe, is one which, within certain limits, is beneficial to the animals who are the objects of it—though those last mentioned would be inserted in a list of the destroyers of the animal kingdom—which contribute to maintain a just balance between the different members of it. The fly that bites the horse prevents it from overfeeding, and so the leeches may be of use to the larger aquatic animals, at the same time that the smaller ones, such as the grubs of insects, must generally perish from the insertion of their sharp jaws, and the suction of their proboscis.

Yet, as we see, this is one of the animals that man has taken into alliance with him, and this no doubt Providence intended he should, and probably directed him to it, I mean by causing certain circumstances to take place that attracted his attention and indicated its probable use. So that what at first put him to pain, and caused him alarm, he found, upon trial, might be rendered a very valuable addition to his means of cure when attacked by disease, or when he was suffering from a local injury.

The leech tribe, besides its utility in the exercise of its own function, may be useful as affording nutriment to some other animals, as fishes and birds.

The *earth-worms*[1] form a principal feature of the next Order, and afford a delicious morsel to birds of every wing. The fisherman also baits his hook with them, and the ground-beetles[2] often make a meal of them, so that had they no other use, still they would be a very important part of the creation. But their great function appears to be that of boring the earth in all directions, whereby they are useful to the farmer and grazier, giving a kind of under-tillage to pasture and other lands, and by the casts which they every where throw up, they help to manure the soil, and do the same for pastures, that the spade does for the garden and the plough for arable land, place the soil that laid below above. Their food being vegetable detritus, what passes from them must be very good manure.

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[1] *Lumbricus (Enterion Sav.) terrestris.* L. &c.

[2] *Carabus.* L.

The anatomy of these well-known animals is very singular and well worthy the attention of the physiologist and zootomist, the only circumstance relating to it that I shall here mention is that their long body is not only divided externally into rings, but internally into an equal number of cells separated from each other, if I may so speak, by a kind of dissepiment or diaphragm—there are more than a hundred of these cells in the common species, as appears by Mr. Bauer's admirable figures in the *Philosophical Transactions* for 1823, to which I must refer the reader for further information on this subject, first observing that there seems some analogy between the cells of the earth-worm and the joints of the tape-worm.

The motion of these animals, and of many other Annelidans, is accomplished by means of the rings of their body and their lateral bristles; the latter the Creator has given to them, in the place of legs: pushing with the anterior portion of these against the plane of position, by contracting the rings, they bring up the posterior portion of their body, and then fixing that part, extend the anterior rings, and so proceed successively with a kind of undulating motion.

3. We are next to notice a tribe of Annelidans, many of which, in one respect, make some approach to the Testaceous Molluscans. Though truly annulated and furnished with a kind of false legs, they are defended by a shell resembling in its substance, that of the class just alluded to, but often by its irregular convolutions proving that it belongs to an Annelidan and not to a Molluscan; some indeed approach to the spiral convolutions of a Trachelipod shell; others form a membranous sac, and cover it with agglutinated particles of sand, as the common *Sabella;* others again, likewise inhabit a tube, but they fix it in the rocks. The testaceous animals of this class, particularly the worm-shells,[1] inhabit a tortuous tube which they form, probably with more ease and celerity than the Molluscans form their shells—for they appear almost to do this as they move, since the shape of the shell imitates the sinuous windings of a worm, and that of the *Serpula* adheres to the substances on which it is formed. We see it often upon the shells of bivalves, to which it adheres by the lower sur-

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[1] *Serpulidæ.*

face, looking like a little worm creeping upon them;[1] and forming convolutions; I have a specimen on a valve of the cock's-crest oyster,[2] which is bound down by a process issuing apparently from the disk of the oyster-shell itself, how produced and thrown over the *Serpula* it seems not easy to conjecture. Different species of these worm-shells are often found, embracing each other with their convolutions, on the same shell; wherever the sea is or has been, they abound either in a recent or fossil state; they are found on rocks, and sea-weed as well as on marine shells, and those of lobsters. The Serpulidans, in general, imitate the spiral structure of the Trachelipod and other Molluscans, as is particularly evident in *Siliquaria* and *Vermetus*, if indeed the last genus is not itself a Molluscan, as Lamarck makes it.

Other species of this Order are taught to establish themselves in fissures of rocks, which serve them instead of a shell to protect the membranous tubes into which they retract their petaliform tentacles, which together represent a beautiful radiated blossom, or the nectarium of a passionflower. Of this kind is the *Magnificent Amphitrite*, figured in the *Linnean Transactions*.[1] It is found in the rocks of various parts of the coast of Jamaica. When alarmed, it retracts its tentacles within its tube, and the tube itself into the rock. How it excavates its rocky burrow has not been ascertained.

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[1] *S. Triguetra.*

[2] *Ostrea Crista-galli.* Since the above was written, in the collection of the late Peter Collinson, I have seen two specimens of this oyster, which had produced from the back of their shell a double series of processes, with which, as with so many fingers, they had taken firm hold of a piece of stick.

The *Sabellæ*, which pass under various names in different authors, inhabit the sandy parts of the shore, and like certain case-worms form a covering for their tube of selected grains of sand, mixing sometimes other substances that suit their purpose, which, by some secretion at their disposal, they glue pretty firmly together so as to form a neat case tapering towards the tail. The animal buries itself and case in the sand, with its head towards the surface, so, probably, as to enable it to protrude it and expand its tentacles to collect its food when covered by the water. The bristles of the legs in some species resemble burnished gold.

The functions of a large proportion of the animals of this order seem to correspond with those of the bivalve shell-fish; they undermine the sands and the rocks, bore into sponges and corallines, and other submarine substances, and some probably, into submerged wood: like them, also, they seem to feed on animalcules brought within their reach by the tide. The Serpulidans, whose food is similar, are directed by the will of their Creator to affix themselves externally to any submerged bodies that come in their way, whether mineral or animal. All they require seems to be something to attach themselves to, on which they can protrude their tentacular gills, and seize their prey. They must contribute largely, as well as the mining Annelidans of this order, to the production of calcareous matter. Mr. Sowerly suspects that their proboscis may be instrumental in forming the shell, but it seems not properly a proboscis, but merely an operculum on a long footstalk, which was requisite that it might be protruded so far as not to interfere with the action of the gills.

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[1] *Tubularia magnifica*. Shaw.

The animals included in Mr. Savigny's first Order, the *Nereïdeans* bring us very near to the Condylopes. They have a distinct head, jointed organs like antennæ, eyes, a proboscis armed with maxillæ, and spurious legs. They have also certain dorsal scales, which M. Savigny calls elytra, and deems analogous to the organs of flight in insects. These animals seem to afford the first example of the conversion of organs of locomotion into others, employed for a different purpose. I do not mean by this, that, in the progress of the animal's growth, one organ is really converted into another, but that analogous organs, in different tribes or genera, are employed for different purposes. Thus, what in most Annelidans are locomotive organs, in *Lycoris*, *Phyllodoce*, and some other Nereïdeans[1] become a kind of tentacle. The marine *Scolopendra* of Aristotle most probably belonged to this Order, and many species make a near approach to the terrestrial ones.[2] Like them they are long and often flat, consisting of a great number of segments, some having between two and three hundred, furnished according to the species, with one, two, or three pairs of legs in each; like them also they twist about in all directions when handled, they conceal themselves in close places where they lie in wait for their prey. In one respect some of them add the instinct of the spider to that of the centipede, for they line and sometimes cover the cavities of the rocks which they inhabit with a slight silken web, and thus concealed they watch the approach of some animal, and, suddenly thrusting out the anterior part of their body, seize and devour it.

My late indefatigable and talented friend, the Rev. L. Guilding once found a *land* species, in an ancient wood in the Island of St. Vincent's, which from its soft body he regarded as a Molluscan, but from its figure, and annulose structure, its jointed antennæ, and seemingly jointed legs crowned with bristles, it[3] certainly belongs, as Mr. Gray has remarked, to the present class.

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[1] Savigny, *Syst. des Annel.* 9, 12, 13.

[2] PLATE VIII. FIG. 4.

[3] PLATE VIII. FIG. 1. Mr. G. calls it *Peripatus juliformis*.

Though it has scarcely a distinct head, its resemblance to the cylindrical myriapods[1] is very striking. Other species of this Order resemble the Isopod Crustaceans, and some even roll themselves up like one tribe of them.[2]

These animals have their haunts sometimes in deep burrows and passages under the sea-weed or in the sea-sand. They are so fierce in their habits that some have been styled the tigers of the worms. Some fishes in their turn make them their prey. Many of them, as the sea-mouse,[3] are remarkable for the brilliancy of their metallic hues. Perhaps these dazzling splendours, as in the case of some insects,[4] may be of use to them in preventing the escape of their prey. Their forms and instruments of locomotion seem particularly adapted to the situation and circumstances in which they are placed; their legs, which approach the jointed legs of crustaceans and insects, fit them for moving on the surface of the bed of the sea, their oars for swimming in the water, and the long form of many for threading the sinuous paths and burrows in which they have their habitation and place of refuge. So exactly are they fitted by the skilful hand of the almighty and benevolent Architect of all animal forms to live and move in the place he has assigned to them.

[1] *Julus*. L.

[2] *Nereis Armadillo.*

[3] *Aphrodita aculeata.*

[4] *Introd. to Ent.* ii. 221.

APPENDIX.

Since the preceding part of this treatise had mostly passed through the press, I have had an opportunity of consulting some recently published works, which contain accounts, illustrated by figures, of many very interesting animals belonging to several of the Classes of which I have there treated; and all of which more or less demonstrate a presiding Intelligence immediately connected with the globe that we inhabit, and who, viewed under every aspect, evidently careth for us, and all the creatures he has made. I shall select a few of these for the consideration of the reader.

I formerly observed[1] that types representing some of the higher forms of the animal kingdom were often to be detected amongst those belonging to its lowest grade: a remarkable instance of this may be seen in one of Ehrenberg's late works,[2] in which is described and figured a singular Polygastric Infusory, which seems to exhibit the first outline of an Arachnidan[3] form; it has eight locomotive organs or bristles, representing the eight legs of those animals.[1] By means of these organs, this animal, which was found by Dr. Ehrenberg in the Red Sea, performs a double rotatory movement, one by the rotation of the anterior pair, and the other by the three posterior pairs. The motion of these filamentous legs is so rapid that they appear as if, instead of eight, a hundred were revolving, and so form a kind of natural Phantasmascope. Another infusory genus, *Bacillaria*, seems to prefigure the *Salpes*,[2] the species at first being concatenated in chains or ribands, and afterwards separating.[3] The animalcules forming this genus have sometimes been mistaken for plants, and the quadrangular form of the associated individuals gives them the appearance of the jointed stem of a plant, rather than of an animal chain. On a former occasion, I alluded to other imitations of the vegetable world exhibited by the polypes, particularly to some of them producing seeming blossoms, consisting, as it were, of *many* petals.[4] I shall now notice some that represent *monopetalous* flowers. A genus long known to naturalists, which seems intermediate between the Infusories and the Polypes, named originally by Linné *Vorticella*, exactly simulates a bell flower with a spiral footstalk. They are often found in fresh water, and present no unapt representation of a bunch of the flowers of the Lily of the valley, whence one species has been named *Vorticella Convallaria.* Some of these have branching, and others simple stems,[1] but they are all spiral, and capable of being lengthened or shortened at the will of the animal, which is thus enabled to elevate or depress its little blossoms, the mouths of which are furnished with a double circlet of filamentary tentacles, by the rotation of which, like the rest of its tribe, it can produce a food-conveying current to its mouth. Still nearer to the Polypes, with which indeed it is arranged, is another genus representing monopetalous flowers, named by Ehrenberg, who found it in the Red sea, *Zoobotryon*, or *Animal-grape.* This singular animal production will scarcely arrange under any of the Orders mentioned on a former occasion, but it may be regarded as intermediate between the Rotatories and the Polypes. Like the latter it is a compound animal, consisting of a naked branching stem; its lower extremity, as may be seen in the figure,[2] appears as if sending forth numerous little radicles, and the branches terminate in ovate germs, from which issue a multitude of animalcules resembling monopetalous bell-shaped flowers, with the mouth surrounded by a filamentous coronet, each sitting upon a spiral elastic footstalk, by means of which the animalcule can either draw itself close to the stem, or, shooting out, dart on either side after its prey. When the mouth of every individual is open, each germ looks like what botanists call a *raceme* of bell-shaped flowers; and, when they are closed, they resemble a bunch of grapes.[1]

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[1] See above p. 320.

[2] *Symbolæ Physicæ.*

[3] *Discocephalus Rotator.*

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[1] PLATE I. A. FIG. 6.

[2] See above, p. 222.

[3] PLATE I. A. FIG. 4, 5.

[4] See above, p. 169.

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[1] See above, p. 166.

[2] PLATE I. B. FIG. 2. *a.*

To the class of *Worms*, especially those that have been denominated *Entozoa*, or internal worms, I have a few interesting additions to make, taken from a work of Dr. Nordmann's,[2] some of which are so extraordinary and wonderful, both as to their functions and structure, that the great object of the present treatise, *Gloria Dei ex opere naturæ*, will receive considerable illustration from some account of them.

Dr. Nordmann's first treatise is upon a tribe of these creatures that are interesting from their very singular situation, in the *Eyes*, namely, of the higher animals.

Amongst the personal pests of our own species, enumerated in the chapter above alluded to,[3] I mentioned none that attacked the organs just named; but this learned investigator of parasitic worms has noticed two which have been detected in them; one related to the *Guinea-worm*,[4] which was extracted from the eye of a person affected by a cataract;[1] and another, a *Hydatid*,[2] from the eye of a young woman.

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[1] PLATE I. B. FIG. 2. *b*.

[2] *Micrographische Beïträge*, &c.

[3] See above, p. 324.

[4] *Filaria medinensis*.

Besides those that infest our own visual organs, quadrupeds, birds, reptiles, and fishes, have each their *eye-worms*. Amongst those to which the will of Providence has assigned their station in the eyes of the latter class of animals, is a remarkable one,[3] which Dr. Nordmann discovered in those of several different species of *perch*,[4] sometimes, in such numbers, as must have interfered with that distinct sight of passing objects, which appears necessary to enable predaceous animals to discover their prey in time to dart upon it and secure it; in a single eye the Doctor detected, in different parts, 360! of these animalcules: when much increased they often produce cataracts in the eye of the fishes they infest. This little animal appears something related to the *Planaria*, or pseudo-leach, and, to judge from Dr. Nordmann's figures, seems able, like it, to change its form.[5] Underneath the body, at the anterior extremity, is the mouth; and in the middle are what he denominates two sucking-cups;[6] these are prominent, and viewed laterally form a truncated cone; the anterior one is the smallest and least prominent, and more properly a sucker; the other probably has other functions, since he could never ascertain that it was used for prehension.

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[1] *F. Oculi humani.*

[2] *Cysticercus cellulosæ.*

[3] *Diplostomum volvens,* PLATE I. B. FIG. 5.

[4] Ibid. FIG. 6.

[5] See Nordmann's *Micrograph*, i. *t.* ii. *f.* 1—9.

[6] Saugnäpfe.

A kind of *metamorphosis* seems to take place in these animals, for our author observed that they appeared under *three* different forms.

These little pests, small as they are, have a parasite of their own to avenge the cause of the perch, for Dr. Nordmann observed some very minute brown dots or capsules attached to the intestinal canal, which when extracted, by means of a scalpel formed of the thorns of the creeping cereus,[1] and laid upon a piece of talc, the membrane that inclosed them burst, and forth issued living animalcules, belonging to the genus *Monas*, and smaller than *M. Atomus*, which immediately turned round upon their own axis with great velocity, and then jumped a certain distance in a straight line, when they again revolved, and again took a second leap.

Looking over our author's list of eye-worms that infest fishes, we find that five out of seven are attached to different species of perch, and one cannot help feeling some commiseration for these poor animals; but when we recollect that they form the most numerous body of predaceous fishes in our rivers, we may conjecture that thus their organs of vision are rendered less acute, and that thus thousands of roach, dace, carp, and tench may escape destruction. The ever watchful eye of a Father Providence is over all his works, and he has provided means, in every department of the animal kingdom, so to limit the inroads of the predaceous species, that a due proportion and harmonious mixture may every where be maintained, and that with respect to every individual species. The means are various, but the end is one; and the partial evil terminates in the general good and welfare of the whole.

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[1] *Cactus flagelliformis.*

Next to the *eyes*, the *gills* of fishes are subject to annoyance from internal worms; and amongst these there is none more remarkable or wonderful than one first discovered by Dr. Nordmann, upon those of the *bream*,[1] and to which, on account of its remarkable structure and conformation, he has given the name of *Diplozoon*, or *Double animal*. In the Classes of Polypes and Tunicaries we have been introduced to many animals that appear to be compound; which, from a common stem or body send forth numerous *oscula* or mouths, in this emulating the members of the vegetable kingdom: but amongst all these plant-animals,[2] there is none can compete with this of Dr. Nordmann, which, like the Siamese youths, appears to be formed of two distinct bodies, united in the middle so as to present the appearance of a St. Andrew's cross, each half of the animal containing precisely the same organs; namely, an alimentary canal, a system for circulation and generation, and also a nervous system. Müller calls the innumerable and varying cohorts of the animal creation *preachers* of the infinite wisdom and power of the Sovereign of the world;[1] and this is one of the most wonderful of them all, which singularly exemplifies those attributes.

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[1] *Cyprinus Brama.*

[2] *Phytozoa.*

At first it might be imagined, that, like the youths just alluded to, this was a monstrous production of nature; but Dr. Nordmann relates that he has found *thirty* specimens, precisely agreeing with each other, all in a similar situation, attached namely, to the gills of the fish mentioned above, and he never found it single, or in any other situation: there can, therefore, remain no doubt on the subject. In order to find these animals, it is necessary to examine all the leaves of the gills separately under water, or to separate the lesser whitish ones with a pointed instrument, when the animal may be detected by its movements: its station is between the leaves or folds of the inner gills.

This singular creature consists of two lobes, or arms, above the point of union, and two below it. The upper pair are the longest and most divergent: they are somewhat lance-shaped, and at the extremity of each, on the under side, is a mouth, with a sucker, divided by a fleshy transverse septum; by means of these suckers, the mouths of this two-bodied monster are kept steady, so as to suck without intermission. The orifice of the mouth is large, and, when fully open, triangular: there is also an organ within the gullet which seems analogous to a tongue, resembling the sucking organ of the pseudoleech. The alimentary canal branches out on both sides into numerous blind vessels. The whole of this canal, like the creature itself, is cruciform. The circulation of the blood is very visible: each half of the animal has on both sides two principal blood vessels, which are every where of almost equal diameter, without any enlargement; in the two exterior ones the blood runs upwards, and in the two interior ones downwards, and its motion is extremely rapid. The generative organs and ovaries are also double. The feces, as in the polypes and other lower animals, pass out at the mouth. The two lowest lobes are somewhat club-shaped, or thickest at the extremity, towards which, in each, are two oval plates, or disks, containing four oblong *acetabula*, or suckers: the bodies below the plates terminate in a triangular piece, or flapper. In some of their movements it seems as if the two upper lobes had different *wills*, since sometimes one appears inclined to move to the right, and the other to the left, or one to move and the other to remain at rest; but the lower lobes always move simultaneously, either inwardly or outwardly.

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[1] *Entomostraca.* 27.

The animals that are found attached to the gills of other fishes are usually at their lower extremity furnished with several suckers; thus one genus[1] infesting the gills of the sun[2] and sword fishes[3] has *three;* and another,[4] found in those of the tunny,[5] has *six*, whence Cuvier would rather call it *Hexastoma*. But these are nothing to those of our *Diplozoon*, which, on the four disks just named, has no less than *sixteen* suckers, four on each disk.[6] Under a strong magnifier, these suckers when opened, for they can open and shut, exhibit a complex machinery of hooks and other parts, by which their Creator has enabled them to take firm hold of the gills, so as not to be unfixed by their constant motion in respiration, especially when we consider their structure and substance. A further proof of this *design* is furnished by the form of the animal itself, for the body being divided upwards and downwards into two diverging lobes, it can fix itself at each extremity more firmly than if it was single, not only by having more points of attachment, but also by the divergement of its lobes, especially the lower ones. When a man wishes to stand as firmly and steadily as possible, he separates his legs so as to form a certain angle: and this is what its Creator has fitted our animal to do; and so by all these means it maintains its station on the lubricous, multifid, and constantly moving organs, from which it is commissioned to suck the blood. Probably these Diplozoons may be of the same use to the fishes they infest, as the horse-flies are to the animal from which they take their name.

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[1] *Tristoma*. [2] *Mola*. [3] *Xiphias*.

[4] *Polystoma*. [5] *Scomber Thynnus*.

[6] Even this is nothing to those of a genus infesting some Cephalopods, *Hectocotyle*, the different species of which have from sixty to more than one hundred suckers, whence their name.

Dr. Nordmann found this creature could exist submerged for three days, during which period its movements became gradually more feeble. One specimen, which he fed twice a day with fresh fishes' blood, lived nine days in water, and appeared to die at last from being too much handled.

What can more evidently illustrate both the power, wisdom, and goodness of the Deity than this most extraordinary animal? How nicely is it formed, in every respect, to fulfil the functions given in charge to it! How admirably is it secured against the mischances to which its singular situation exposes it! When we see so much art and skill put in action to adapt such seemingly insignificant creatures, and so low in the scale of creation, to the circumstances in which they are placed; so many contrivances, exhibiting the deepest intellect, taking the most comprehensive surveys of every possible contingency, and rearing a structure calculated to stand against every pressure upon it,—we must feel convinced that the attention of the Creator is directed to every *individual* in existence, whether great or small, high or low, spiritual or material. To every thing that he created he gave a law, the law of its nature; a law emanating from Him, enforced by the physical powers acting upon certain structures, and producing certain necessary effects under His *constant* superintendence, direction, and action, on and by those powers.

The intestinal worms, as well as some other parasitic animals, are many of them so remarkable for the situation in which we discover them, that their transport to the spot where they are to exercise their function seems almost miraculous. How a mite should find its way into the human brain seems past our conjecture. We cannot clearly ascertain by what means the eye-worms are conducted to their assigned station, nor how the various species of tape-worm invariably select each its proper pabulum: the same holds good with regard to the cyst-worms,[1] or hydatids. Do they, like the *Infernal Fury*,[1] as fabled by Linné, fall from heaven upon the earth and waters, and instantly bury themselves in their allotted animals? But to speak soberly, all we can safely affirm is, that He who decreed the *end* decrees the *means*, and these probably are physical ones under his direction. He it is who guides the punitive animals that he employs to their several stations. Is there not an omnipresent Deity, whose action is incessant, and coextensive with his presence? He it is that, as the Prophet speaks, causeth it to rain upon one city, and not to rain upon another city; that employs his instruments, both of benediction and punishment, according to his will. It is He, who by secret paths, and by means that mock our researches, conducts to their assigned station the animals in question. Every power of nature, every physical agent, is at His disposal. His is the earthquake and the volcano; *the lightning of the thunder;* the fire-damp of the mine; the overwhelming violence of the water flood; *the windy storm and tempest:* His is the wide-wasting sword, that destroys myriads, and *the pestilence that walketh in darkness,* and carries off millions; and He gives his commission to all his scourges against individuals as well as against nations, which they unconsciously execute and cannot exceed, for He saith to them, as to the raging sea, Hitherto shall ye come and no further, and here shall the work of destruction cease.

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[1] *Cysticercus.*

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[1] *Furia infernalis.*—L.

We have a remarkable instance of this special guidance and employment of natural objects in the case of the prophet Jonah, when he disobeyed the word of the Lord. In the first place God *sent out* a great wind into the sea; in the next he *prepared* a great fish to swallow him alive when he should be cast overboard, and at the Lord's *command* the same animal cast him upon the dry land. Next God *prepared* a gourd for a shadow against the heat; after that he *prepared* a worm which destroyed the gourd; and in the last place he *prepared a silent east wind*,[1] or a heat, like the sirocco, without sound. In all these cases the object employed was a physical object, under the immediate direction of the Deity. The wind, the fish, the gourd, the worm, the heat, were not new creations, but well known objects, acted upon to take a particular direction so as to produce particular events.

By what is here said, I by no means assert the doctrine of inevitable fate, for then there would be no use in the employment of means of prevention. Sir H. Davy's safety-lamp would not preserve the life of the miner, nor Dr. Franklin's conductor disarm the thunder cloud; and all the other means that, *non sine Deo*, have been invented to render harmless the action of the physical powers under certain circumstances; but I would merely assert that constant superintendence of the Deity over the world that he has created, and *Who upholdeth all things by the word of his power*, which we call Providence, by which, in general as well as individually, his will has full accomplishment; and every substance or being, whether animate or inanimate, takes the station which he has assigned to it. This is no miraculous interference out of the general course of nature, but the adaptation of that course to answer the wise purposes of Providence, which selects individuals, and distinguishes them from other individuals by events, as to this world, seemingly prosperous or adverse, but which have their ultimate reference to the spiritual world, and to their final destiny. As God willeth not that any should perish, so he withholdeth not from any the means, that, if duly used and improved, will be sufficient for his salvation; and in all his dealings with mankind he hath this great and merciful object in view.

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[1] רוח קדים חרשית.

APPENDIX. NOTES.

NOTE 1, p. 2.—*The life and motion.* The word *life* may perhaps here be used, in some sense, improperly; but the original motion caused by the agency of the Spirit, and followed by Light and Expansion, may be called the birth, or beginning, of the life of the world, which followed, under the Divine Guidance, as a consequence of it. I speak only of *animal* life, not of *spiritual,* which resulted from the immediate insufflation, if I may so use the term, of the Deity himself.[1]

I may here be permitted to observe that the Mosaic account of the beginning of creation, especially of the incubation of the Holy Spirit and its consequences, has been transplanted, by many oriental and occidental nations, into their cosmogonies. The circumstances and consequences of it have, in most cases, been altered from their original simplicity; and, in some, it has been assumed as a foundation, on which an Atheistic Philosophy has been erected amongst the Greeks. But when we consider attentively the terms in which these dogmata are delivered, and recollect that the Gods of the Greeks and Romans, especially him who was invocated as the father of gods and men, were really the great elementary powers which under God govern the universe—whence Homer describes him as *αιθερα ναιων*, and calls him *Ζευς νεφεληγερετης*, and Ennius appeals to him in these terms,

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[1] *Genes.* ii. 7, comp. *John*, xx. 22.

> Aspice hoc sublime candens quem invocant omnes
> Jovem.

And to live abroad is to live *sub Jove, sub Dio*. It is evident that these Gods were *subsequent* to Chaos, and sprung from that motion of the Spirit which first gave birth to this world as we behold it; besides these, the sun, moon, planets, earth, ocean, &c. made part of the catalogue of false Gods whom the Heathens worshipped and served instead of the Creator. These powers, which were originally reverenced as symbols and representatives of the Godhead, and, as it were, his vicegerents in Nature, in process of time were thus regarded and adored as the supreme and only God—the sign instead of the thing signified—the instrument instead of the hand that guided it—the work instead of the workman. They deemed, as the author of the Book of Wisdom observes,[1] *Either fire, or wind, or the swift air, or the circle of the stars, or the violent water, or the lights of heaven, to be the Gods which govern the world.*

Veneration and love to those from whose actions or studies we derive great benefit, and respect for our ancestors, amiable motives when they do not lead us away from God, often induce mankind to throw a kind of Divinity, a ray of glory, around such persons; first, perhaps, they are complimented with the title of *suns* of their people or race, and their wives as *moons*, and next we transform them into what we regarded as their symbol. So the Egyptians, in process of time, added the adjunct *On*, or the *Sun*, to the name of their great ancestor,

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[1] *Wisdom*, xiii. 2.

Ham; whence he was afterwards designated as Hamon, or Ham the sun, and became the Jupiter Ammon of the Greeks.[1]

The idea of the incubation of the Spirit, of its being the principle of love that was in action, and that it produced the first motion, prevails, more or less, in all the cosmogonics.

Aristophanes, in his *Aves*, gives an account of the Grecian cosmogony, which proves that the heathen gods of the Greeks were all subsequent to the original creation of matter, in a passage, of which the following lines are nearly a literal translation:

Once Chaos was and Night, dark Erebus
And ample Tartarus; but Earth, and Air,
And Heaven were not. First blackwing'd night
In th' infinite gulfs of Erebus brought forth
The wind-nurs'd egg, from which in circling hours,
Love the desir'd, his shoulders golden-wing'd,
Sprung like a wind-swift vortex, he who mix'd
With Chaos wing'd and dark, and Tartarus wide
Nested our race, and them brought first to light.
Ere love commingled all, *immortal Gods*
Were none, but from that commixture rose
Heaven, Sea, and Earth, *and Gods incorruptible.*

Wind-nurs'd egg. Gr. ὑπηνεμιον ωον. Literally, the egg under the wind, alluding to the incubation of the Spirit.

Love. This is the motion infused by the Spirit into the chaos which was followed by light and expansion, and the whole harmonious circle of creation, in which there was no discord, but all was very good.

His shoulders golden-wing'd. Gr. Στιλϐων νωτον πτερυγοιν χρυσαιν. Literally, his back shining with *two* golden wings; these two golden wings were, perhaps, *light* and the *expansion*, which carried love through his whole work.

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[1] *Cudworth*, I. ii. 338.

Sprung. Gr. Εϐλαστεν, germinated.

Wind-swift vortex. Gr. εικως ανεμωκεσι δὶναις. Literally, like whirlwinds or whirlpools, swift as the wind.

He who mixed with Chaos wing'd and dark. Gr. Οὖλος δε χαει πτεροεντι μιγεις νυχιω. This describes *love* or *motion* entering into chaos and beginning to produce order.

Nested our race. Gr. Ενεοττευσε γένος ἡμετερον. The birds here claim an early origin. The allusion probably is to the mundane egg and the birth of winged love.

But from that commixture rose heaven, sea, and earth, &c. Gr. Συμμιγνομενων δ' ἑτερων ἑτεροις, εγενετ' ουρανος, ωκεανος τε, καὶ γη, παντων τε Θεων μακαρων γενος αφθιτον. Literally, "one thing being mingled with another, heaven, ocean, and earth, and the incorruptible race of all the immortal Gods were produced."

It is evident from this passage that those whom the Greeks accounted their Gods were the elements, the heavenly bodies, and other works of creation. *Thus they changed the truth of God into a lie, and worshipped and served the creature more than the Creator, who is blessed for ever.*

NOTE 2, p. 5.—*Kindred Monsters.* I allude here to the gigantic *Reptiles*, those especially which are now seen only in a fossil state, many of which instead of legs are furnished with paddles; as the *Ichthyosauri* and *Plesiosauri.* These animals seem intermediate between the amphibious Saurians and the Chelonians. Some of them also exhibit several characters in common with some of the Cetaceans, Amphibians, &c.

NOTE 3, p. 8.—*Intermediate, as it were, between matter and spirit.* I find a similar idea in the *Nouveau Dictionnaire D'Histoire Naturelle,*[1] "Le mot de matière porte avec soi l'idée d'un corps lourd et grossier: cependant il est des substances auxquelles on donne le nom de matière, telle que la matière éthérée, et qui sont d'une si inconceivable tenuité, qu'on diroit qu'elles tiennent *le milieu entre l'esprit et la matière.*" Sir Humphry Davy seems to have adopted a similar opinion, which I have given in another part of this work;[2] and Dr. Wollaston also, *in his Religion of Nature delineated,* asks—"Might it not be more reasonable to say, *it* (the soul) *is a thinking substance intimately united to some fine material vehicle which has its residence in the brain?*"[3] And again—"If we should suppose the soul to be a being by nature made to inform some body, and that it cannot exist and act in a state of *total separation* from all body; it would not follow from thence, that what we call death, must therefore reduce it to a state of absolute insensibility, and inactivity, which to it would be equal to non-existence. For that body, which is so necessary to it, may be some fine vehicle that dwells with it in the brain, and goes off with it at death.[4] This vehicle, which is so necessary to the soul, dwells with it in the brain, and goes off with it at death, he further supposes, is that by which it acts and is acted upon, by means of the nerves.[5] This vehicle seems not very different from the *vital powers* of modern physiologists, who regard the nervous power as their agent.[6]

The Doctrine of a vehicle for the soul which accompanies her when separated from the body is not a modern hypothesis, but was held by the Platonists and many of the fathers.[1]

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[1] xix. 449. article *Matières.* Patrin.

[2] See VOL. II. p. 253.

[3] P. 192.

[4] *Ibid.* 196.

[5] *Ibid.* 197.

[6] Dr. Wilson Philip, in *Philos. Tr.* 1829, 271, 278.

Our Lord says to his disciples—*The hairs of your head are all numbered:* upon which we may observe that the head of man is clothed with hair to answer a certain end, an end which has not yet been duly investigated, but which in Scripture has been *intimated* by making it the symbol of *strength* or *power*—by which latter term it is designated by St. Paul[2]—as in the case of Samson, whose superhuman strength seems to have departed from him, when his *seven* locks were shorn off; symbolizing might from the seven spirits of God,[3] or in other words, the sevenfold might of the Spirit. It is well known that the hair is affected by the electric fluid, and it may conduct it to the brain or other organs. Whatever be its function, however, its force will depend upon the quantity, and the quantity upon the number of conductors, and this God regulates in the case of individuals, according to circumstances, so that, though some receive more and some less, *He that receives much has nothing over, and he that receives little has no lack.*[4]

NOTE 4, p. 9.—*For if the instinct of the predaceous ones was not restrained, they would soon have annihilated the herbivorous ones, even if, as Lightfoot supposes, they were at first created by sevens.* If the fall of man, as is generally supposed, happened soon after his creation, the first sacrifice, which as the Lord God clothed the first pair with skins before their expulsion from paradise, must have been offered immediately after the former sad event, would have caused the annihilation of a species; which, in conjunction with the circumstance of Noah being directed to admit *clean* animals into the ark by *sevens the male and his female,* afforded no slight ground for Lightfoot's supposition alluded to in the text. He thus expresses his opinion. "*Bestiæ mundæ creatæ sunt septenæ, tria paria ad prolem, et reliquæ singulæ Adamo in sacrificium post lapsum: at immundæ tantummodo binæ, ad generis propagationem.*"[1] Lightfoot here speaks of *three* pairs and *a half,* and some writers quoted by Poole, seem to think, that the same number were received into the ark, and that the seventh, a male, was intended for sacrifice after the deluge; others think there were seven *pairs.*

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[1] See Dr. H. More, *On the Immortality of the Soul*, B. iii. Axiome xxvii. and Cudworth's *Intellectual Syst.* 799.

[2] 1 *Cor.* xi. 10.

[3] *Revel.* i. 4, 5.

[4] 2 *Cor.* viii. 15.

Note 5, p. 11.—*In the fiercest enmity and opposition to each other.* There was a show-man, who in the year 1831, exhibited on one of the London bridges, as I was informed by a friend upon whose accuracy I could rely, the animals here spoken of in a state of reconciliation. In one cage were *cats, rats,* and *mice,* and in another *hawks* and *small birds* living together in the utmost harmony, and without any attempt on the part of the predaceous ones to injure their natural prey.

Note 6, p. 16.—*Concerning the kind of which interpreters differ.* The Septuagint renders the Hebrew word כנם, which our translation renders *lice,* by σκνιφες, which is supposed to mean the *mosquito* or gnat, but I cannot help thinking with Bochart,[2] that it rather means the

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[1] Lightfooti *Opera,* Ed. Leusden. i. 154. conf. 2.

[2] *Hierozoic.* 574.

louse, not only on account of its derivation from a root, כן, which signifies to fix firmly, which agrees better with the animal just named than with the mosquito, but also because it was produced from the *dust* of the earth like other apterous animals, and not from the *waters*, like the winged ones.[1] The African negroes, as was before observed, have a peculiar louse.[2]

NOTE 7, p. 17.—*Geologists have observed, from the remains of plants and animals embedded in the strata of this and other northern countries, that the climate must formerly have been warmer than it now is.* That the inclination of the earth's axis was once different from what it now is was a very ancient opinion; but whatever might be the cause, the fact seems to have been certain, from the existence in very high latitudes of the plants and animals here alluded to, such as various species of palms, of elephants, hippopotami, turtles, and similar tropical forms. Cuvier indeed has conjectured, that the carcase of a mammoth found in Siberia belonged to a cold climate because it was clothed with wool as well as hair. Its hair was stated to consist of three kinds. One being stiff black long bristles, another flexible hair of a reddish brown colour, and the third a reddish brown wool which grew among the roots of the long hair.[3] Now with respect to sheep, there is evidently a difference with regard to their coat in those that live in warm climates, and those that inhabit cold ones, the coat of the former usually consisting chiefly of hairs, and the latter of wool;[4] but

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[1] *Genes.* i. 21.

[2] *Fabr. Syst. Antliat.* 340. 2.

[3] Cuvier, *Theory of the Earth*, by Jameson, 275.

[4] See above, Vol. I. p. 64.

Dr. Buckland,[1] and Dr. Virey[2] have advanced some satisfactory arguments which prove that the Mammoth could not have existed in the countries in which its fossil remains are so abundant, if it had been exposed to a great degree of cold. It is remarked with respect to the remains of fossil elephants, which are so numerous without the tropics, in regions too cold for their existence, that none have been hitherto found in those countries which they actually inhabit at the present time.[3] This throws no small degree of doubt upon that hypothesis which assigns them for their habitation the countries in which their remains are now deposited: but with regard to the remains of coral reefs[4] found in the Arctic seas, no doubt can be entertained that at the period of their formation, those seas were warm enough to suit the temperature of the animals that formed them; but which no longer exist and rear their structures in those latitudes. I met with the following extract in the Literary Gazette for April 7, 1832; it is taken from a work entitled *Six Months in North America*, by G. T. Vigne, Esq.: "The fossil remains of about thirty animals, now supposed to be extinct, have been found at the Big-bone lick; and Mr. Bullock conjectures that there are more remaining. That these animals did not perish on the spot, but were carried and deposited by the mighty torrent, which it is evident once spread over the country, is probable from the circumstance of marine shells, plants, and fossil substances having been found not only mixed with the bones, but adhering to them, and tightly wedged in the cavities of the skull—' those holes where eyes did once inhabit,' were often stopped up by shells or pieces of coral forcibly crammed into them." The bones of the *Mastodon* were found by Humboldt at an elevation of more than 7,000 feet above the sea, and in central Asia those of horses and deer have been met with at an elevation of 16,000.[1]

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[1] *Supplement* to *Captain Beechey's Voyage*, ii. 355, 356.

[2] *N. D. D'H. N.* x. 162.

[3] *Ibid.* 169.

[4] Dr. Buckland in the *Appendix* to *Beechey's Voyage*, ii. 355.

NOTE 8, p. 19.—*Burchel and Campbell appear to have met with more than one new species of rhinoceros in their journey from the Cape of Good Hope into the interior.* Burchel describes one under the name of *Rhinoceros simus.*[2] Campbell's had a straight horn projecting three feet from the forehead, different from any he had seen, and its horn resembled that of the supposed unicorn.[3] There is in the Norwich Museum a horn flattened at the summit, nearly straight, and three feet long, which also seems to belong to another species.

NOTE 9, p. 23.—*The word of God, in many places, speaks of an abyss of waters under the earth. Scientific men in the present day seem to question this.* The passages in Holy Writ, besides those quoted in the text, that appear evidently to affirm that an abyss exists in the earth, are chiefly the following.

In the book of Genesis, in the blessings pronounced, both by Jacob and Moses,[4] previous to their death, upon the tribes of Israel, in that relating to Joseph, amongst others are mentioned—*The blessings of the deep that* lieth *under*, or as the same words are more literally translated in Moses' blessing—*The deep that* coucheth *beneath.*[1] The expression in these passages evidently alludes to an abyss *under* the crust of the earth, from which blessings may be derived; and which is emphatically described as *couching* beneath, as if the mighty waters it contained were lying in repose like a beast at rest, and chewing the cud, in contrast with the incessantly fluctuating and stormy ocean.

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[1] *Quarterly Review*, No. LVII. p. 155.

[2] *Travels*, ii. 75. *Bulletin des Sc.* Juin 1817. 96.

[3] *Travels*, 295.

[4] Comp. *Genes.* xlix. 25 with *Deut.* xxxiii. 13.

When the children of Israel murmured for water in Rephidim, Moses at the Divine command smote the rock in Horeb, and water flowed out of it in a copious stream, which there is reason to believe followed them in all their wanderings through the wilderness. If we consider the nature of that *dry and thirsty land where no water is*, it is evident that this perennial stream could not be derived from the clouds that hovered round the summits of Mount Sinai, the rocks of that district were washed by no rivers derived from above, and seem not calculated for percolation. But what was the case—the stroke of the wonder-working rod of the Lawgiver of Israel produced a fissure in the rock, which opened a channel through which the waters, before in repose in the great deep, rushed forth in a mighty stream; and therefore the Psalmist says—*He clave the rocks in the wilderness, and he gave them drink, as out of the great abysses.* Alluding evidently to a source of *sweet* waters below.

The prophet Jonah, in the prayer he uttered when incarcerated in the fish's belly, has these words—*I went down to the bottoms of the mountains; the earth with her bars was about me for ever.*[3] A parallel expression is used in Moses' song—*A fire shall burn to the lowest hell—— it shall set on fire* the foundations of the mountains.[4]

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[1] Heb. רבצת תחת

[2] See 1 *Cor*. x. 4.

[3] *Jonah*, ii. 6.

[4] *Deut*. xxxii. 22.

This last passage shews that the *Hades*[1] of Scripture—usually translated *Hell*, but distinct from the *Gehenna* or Hell of the New Testament—is synonymous with the abyss. As is further proved by the following passage of the book of Job. *Hast thou entered into the springs of the sea? Or hast thou walked in the search of the* abyss? *Have the gates of death been opened unto thee, or hast thou seen the gates of the shadow of death?*[2] In this passage the *springs* of the *sea*, the *abyss*, the *gates* of *death*, and the *gates* of the *shadow of death*, seem nearly synonymous, or to indicate, at least, different portions, of the womb of our globe. The *bottomless pit*, or rather the *pit of the abyss* of the apocalypse, also belongs to the same place: the word rendered *pit* means also a *well*. Schleusner, in his lexicon, translates the phrase by *Puteus seu fons abyssi*, so that it seems to indicate a mighty source of waters. But as the terms *abyss* and *great abyss* are applied to the receptacle of waters exposed to the atmosphere, as well as to those which are concealed in the womb of our globe,[3] it is evident that they form one great body of waters in connexion with each other.

Note 10, p. 27.—*He who willed the deluge, and the destruction of the primeval earth and heavens by it, &c.* When it is considered that all the knowledge which we have, and can have, of the contents of the globe that we inhabit, is very *superficial;* that it is only, as it were, *skin* deep, and consequently very imperfect, it seems as if we stood in great need of some other guide, besides our own reasonings and guesses upon the little that we can explore of the earth's crust, to enable us to form a correct judgment, and to arrive at the truth as to what changes may have taken place in it, and by what means. When we further consider that we are informed by the *highest* authority, that the original earth and its heavens, with all their animal inhabitants—those only excepted, which, by his command, took refuge in a vessel built according to his direction—were destroyed by a universal deluge, which overtopped the highest mountains, and continued in force for nearly a year: when this great catastrophe is duly considered, surely, from the account given of it in Scripture, much may be gleaned that will throw a light upon the subject, that can never be struck out by the unassisted investigations of the Geologist who can penetrate so little below the earth's surface.

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[1] Heb. שאול.

[2] *Job* xxxviii. 16, 17.

[3] *Job* xli. 31. *Ps.* cvi. 9. *Isai.* li. 10, &c.

My own knowledge of Geology and its principles, as now laid down, is too slight to qualify me to compare them with what has been delivered in Scripture on the subjects here alluded to; but as it appears to me that the scriptural account of the great Cataclysm has not been duly weighed, and its magnitude, duration, momentum, varied agency, and their consequences, sufficiently estimated by geologists, I will endeavour, as briefly as I can, to call their attention, and that of Christian Philosophers in general, to the most striking features exhibited by it, as stated in the seventh and eighth chapters of the book of Genesis, still requesting them to bear in mind these words of the poet, as expressing my own feelings.

Fungor vice cotis exors ipse secandi.

My only wish being to excite others better qualified, by their knowledge both of Scripture and Nature, the *Word* and the *Work* of the same Almighty Being, to undertake the task.

It must be borne in mind that the scriptural account is not a *figurative* one, in which the object is to represent one thing by another, but a statement of epochs, and naked facts; of causes and effects; in which all that is requisite is to ascertain the meaning of the terms employed to describe them.

The *cause* of the universal deluge, every one is aware, was, with the exception of one family, the universal corruption of the human race. *All flesh had corrupted his way upon the earth.*[1] In consequence of which God determined to—*Bring a flood of waters upon the earth to destroy all flesh, wherein was the breath of life from under heaven; and every living substance from off the face of the earth.*[2] To accomplish this purpose, it was evidently necessary that the whole globe should be submerged, and the tops of all the mountains covered to such a depth as to prevent any thing in which was the breath of life from making its escape.

Having mentioned the *cause* and *object* of the deluge, we must next consider the *means* by which this universal destruction is stated to have been effected. *Three* only are mentioned. *All the* fountains *of the* great deep *were* broken up, *and the* windows *of* heaven *were opened, and the* rain *was upon the earth forty days and forty nights.*[3]

1. *All the fountains of the great deep were broken up.* The radical idea of the word here rendered *broken up* is that of division or disruption, therefore the meaning is that those fountains by which the waters of the great abyss issued ordinarily upon the earth to water it by numerous streams and rivers, were so cleft, disruptured, and broken up, as to form vast chasms vomiting up the fluid contents of the womb of the earth, and sending

[1] *Genes.* vi. 12.

[2] *Ibid.* 17, and vii. 4.

[3] *Ibid.* vii. 11.

forth torrents of incalculable force and volume. The vestiges of such clefts in the earth's crust are still to be traced in many places. Malte Brun, in his *Geography*, observes, with respect to valleys—"Those which are found between high mountains are commonly narrow and long, as if they had originally been only fissures[1] dividing their respective chains, or for the passage of *extensive torrents*. The angles of their direction sometimes exhibit a singular symmetry; we see in the Pyrenees, says M. Raymond, some valleys whose salient and reentrant angles so perfectly correspond, that if the force that separated them were to act in a contrary direction, and bring their sides together again, they would unite so exactly, that even the fissure would not be perceived."[2]

2. *The windows of heaven were opened*—is stated by Moses to be the *second* cause by which the deluge was effected. The word,[3] which in our translation of the Bible, is here and in other places rendered *windows*, does not mean an opening for the transmission of light, for which another term is usually employed.[4] In the Septuagint and other ancient versions it is supposed to signify water falling from the heavens in large masses, and *cataract* or a corresponding term is used.

The radical idea is that of *lying in wait*, as a wild beast in its den. In other parts of Scripture it is used for dovecots, or the holes in rocks that doves frequent;[5] for the sockets of the eyes;[6] for the heavens when shedding copiously blessings or plenty;[7] and for the action of something from above producing earthquakes.[8]

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[1] בקעה is Hebrew for a *valley*, and נבקע is the verb used to express the disruption of the fountains of the great abyss.

[2] *System of Geography*, I. i. 168. E. Tr.

[3] ארבות [4] חלון [5] *Isai.* lx. 8. [6] *Eccles.* xii. 3.

[7] 2 *Kings*, vii. 2. *Malachi*, iii. 10. [8] *Isai.* xxiv. 18.

My venerated friend, the late Rev. Wm. Jones, of Nayland—well known for his knowledge of the Hebrew, and the variety and ability of his researches on every subject connected with the interpretation of Scripture—in his *Physiological Disquisitions* thus expresses himself, concerning the term in question. "We suppose then that the air was driven downwards, for this purpose, through those passages which are called *windows of heaven.* These may seem very obscure terms to express such a sense by; but *heaven* is the *firmament,* or expanded substance of the atmosphere; and *windows,* as they are here called, are holes, or channels of any kind. The same word is used for chimneys,[1] through which smoke passes, and for the holes, probably cliffs of a rock, in which the doves of the eastern countries have their habitation."[2]

It strikes me as not very improbable that the term I am speaking of may allude to *volcanos* and their *craters,* which may be called the *chimneys* of this globe, by which its subterranean fires communicate with the atmosphere, and by which the air rushing into the earth, when circumstances are favourable, may possibly act the part of the fabled Cyclops, and blow them up previous to an eruption: thus they become literally channels or chimneys, through which the matter constituting the expanse or firmament passes, either *from* heaven, or, in an eruption, *towards* heaven. The expression, in Isaiah, quoted above, *The windows from on high*[3] *are opened, and the foundations of the earth do shake*—seems to indicate that *earthquakes* are connected with the opening of the windows of heaven; thus pointing to volcanic action as the result. Still the expression is ambiguous, and requires further elucidation: it may, however, be intended to include both interpretations. The violent disruption of the fountains of the great deep, which appears to have been the first step towards producing the deluge, since God generally employs *means* to effect his purposes, was probably occasioned by the expansive power of *heat*, and the same agent would, as it does at this very time in some countries, send out the waters, and it seems equally probable, that in proportion as the waters rushed out the air would rush in and take their place, and thus form a centre of repulsion, or *vis centrifuga*, to counteract the pressure of the superincumbent waters. It seems not improbable, if this were the case, that in its transit from the surface of the earth, to its centre, the air might bring with it vast cataracts of water attended by thunder and lightning and other electric phenomena.

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[1] *Hosea,* xiii. 3.

[2] *Isai.* lx. 8. See Jones' *Works,* x. 264. See also Parkhurst, *Heb. Lex.* under ארב II.

[3] *Heb.* ממרום

Heat, the most elastic of all fluids, at the first creation, under the name of the *expansion* or *firmament*, acting in the bosom of the chaotic waters divided them, and therefore it is consistent with the Divine proceedings that the same mighty element should be put in action to bring them again together. And we learn from Scripture, that the same irresistible agent will be employed for the destruction of the present earth and its atmosphere or heavens, which are *reserved unto fire, when the heavens shall pass away with a great noise, and the elements shall melt with fervent* heat; *the earth also and the works that are therein shall be burned up.*[1] As the opening of the windows of the heavens seems the consequence of the breaking up of the fountains of the great deep, it is therefore mentioned in the *second* place.

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[1] 2 *Pet.* iii. 7, 10.

3. The *third* instrument of Divine Power to produce the deluge was *rain. And the rain was upon the earth forty days and forty nights.*[1] It is a common form of expression,—It rains as if heaven and earth would come together; and this probably was the character of the rain that now fell for forty *Nycthemera,* or entire days of twenty-four hours. A circumstance that does not require further explanation.

By the united operation of these three mighty agents, guided by the Almighty hand of the Deity—*Whose way is in the sea, and whose path is in the great waters, and whose footsteps are not known*[2]—the waters kept gradually rising and prevailing more and more, till they overtopped all the high mountains[3] that were under the whole heavens fifteen cubits,[4] by which the Divine decree to *destroy* the earth with *all* its inhabitants, both rational and irrational, except those in the ark, was fully executed. With respect to the earth itself, when we consider the violent action of the ascending and descending waters, and of the firmament rushing downwards; the disruptions, dislocations, introversions, comminutions, deportations here and there of the original strata of the crust of our globe, can scarcely be conceived, and are still more difficult to calculate and explain exactly. In the waters thus again, as at the creation, masters of the whole earth, God had an instrument by which his will with respect to its crust, and the changes to take place in it, might have full accomplishment, especially when we consider the long time during which the waters kept rising or prevailed, till they reached the height necessary to fulfil the Divine decree. It seems not clear whether the forty days during which the rain fell are included in the hundred and fifty days that the waters are stated to have prevailed. If they were included, the period would be five lunar months and ten days; and if they were not, it would extend to six such months and twenty-two days. What a time, even according to the shortest calculation, for the continued action of such a body of fluctuating waters, continually increasing, till they left no peak or pinnacle of the most elevated mountains of the globe visible! Who can calculate the effects of that action?

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[1] *Genes.* vii. 12.

[2] *Ps.* lxxvii. 19.

[3] *Genes.* vii. 19. In our translation, ההרים in this verse is rendered *hills*, and in the 20th *mountains*.

[4] *Ibid.* 20.

During this period of the increase and prevalence of the waters, when the mountains were covered, all ingress of the atmosphere into the earth by the chimneys of the volcanos, if that is the meaning of *stopping the windows* of heaven, would cease; and the abyss, at or before the end of it, no longer vomit forth its waters by its innumerable mouths.

Having considered the *secondary* causes to which the Word of God attributes the *rise* and *prevalence* of the deluge, I must next make a few observations upon the means to which Divine Wisdom, Power, and Goodness had recourse to effect this, and to cause the waters to return to their ancient receptacle. At the first creation, *The Spirit of God moved upon the face of the waters.* The consequence of which was that order arose out of confusion. The *motion* was then begun, by which the *wind*[1] bloweth where it listeth, the *light* shines forth, *heat* expands, the *clouds* are formed, and the physical *che-*

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[1] *Ανεμος ουδεν εστι πλην αηρ πολυς ῥεων ὅστις ἅμα και πνευμα λεγεται. Aristot. De Mundo.*

rubim, under the guidance, and according to the will of Jehovah of Hosts, are in action, and fulfil his purpose, and the consequence is that *The waters under the heaven* are *gathered together into one place and the dry land appears.*[1] Similar steps were taken at the deluge. For *God remembered Noah and every living thing, and all the cattle that were with him in the ark: and God made a* wind *to pass over the earth, and the waters assuaged.*[2] It is not here said, as on the occasion just alluded to, that the *Holy Spirit* brooded over the water, but literally that God passed (a) wind (or spirit) over the earth. The action, though not the same, was analogous, *wind* under the *direction* of God was employed to do, in part, what the incubation of the Holy Spirit had before effected, to begin that action by which the globe and its atmosphere would be again placed in statu quo, the water again divided, so that one part should return to the great abyss, its destined abode; and the other be suspended in the atmosphere; and, by the same means, the dislocated crust of the earth be *re*-formed; the matter suspended in the water or floating on it deposited, the detritus of the old one being mixed, and often, as it were, intercalated with vegetable and animal substances and remains. This wind from God having passed over the earth, the waters assuaged; that is, their rage and violence ceased; the fountains of the abyss and the windows of heaven being stopped; the one no longer poured forth its waters upon the earth; and the other no longer descended to occupy their place; and the rain had ceased to fall. When the above three causes of the deluge ceased their action, and had given place to the wind from God, the waters of course began to subside.

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[1] *Genes.* i. 9.

[2] *Ibid.* viii. 1.

We are now arrived at the last epoch of this great event, the gradual decrease and final subsidence of the diluvial waters. The period of their increase, if with Lightfoot we add the 40 days to the 150, would be 190 days, or, as was before observed, six lunar months and about three weeks. *In the seventh month* of the deluge, as the same author observes,[1] on the seventeenth day of the month, the ark rested on the mountains of Ararat,[2] from which period the waters returned off the face of the earth, *going and returning*, as it is in the Hebrew,[3] rendered in our translation by the word *continually*, but almost all the ancient versions adhere to the literal sense, which seems to be important, and to indicate a flux and reflux of the waters, which would affect the deposition of the matters floating upon or suspended in them. Whether this flux and reflux partook of the nature of a tide, and was produced by the action of the moon, or whether it was occasioned by the wind, which, as Solomon observes, *Goeth towards the south and turneth about to the north*,[4] does not appear.

After the resting of the ark, more than two months elapsed before the tops of the mountains were seen, and finally, in nearly two months more the waters had universally disappeared; and after their long domination over the earth, lasting nearly eleven months, were confined again within the limits that God had originally assigned to them. Reckoning *to* the day of Noah's going out of the ark, on the twenty-seventh day of the second month, the whole period of his confinement appears to have been one year and ten days. It is evident, from the period that intervened between the resting of the ark, and the subsequent emergence of the tops of the mountains more than two months afterwards,[1] that the subsidence of the waters at first was very gradual; but, in proportion as their volume diminished, it probably became more and more rapid.

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[1] *Ubi supra.*

[2] See above, VOL. I. p. 45.

[3] Heb. וישבו המים מעל הארץ הלוך ושוב

[4] *Eccles.* i. 6.

The tumult and violence of the *descending* waters, and the effects produced by them, in the new mixture, as it were, of the substances now forming the crust of our globe, and the putting it into its present order—always under the direction and guidance of the Deity, *who sitteth above the water-flood*, employing as his hands those physical agents which rule in nature, to fulfil his purpose—must have been the reverse of those of the *ascending* ones: the object now was not disruption, and dislocation, and destruction, but to form anew the earth and its heavens which had been thus destroyed, and by the addition of a vast body of fresh materials not entering into the composition of the old crust of the former, to render it materially different from it; and that when the attention of mankind was directed to the study of God's works, and of those remains of the former world, a proof might be supplied of the existence of this sad catastrophe, confirmative of the account given in Holy Scripture, and adding to the force of the warning that universal corruption will be a prelude to universal destruction.

When we consider what an infinite host of animals of every description must have perished in the diluvial waters, as well as the incalculable magnitude of the mass of vegetable substances that must have been severed by the violence of the conflicting waters from the earth's surface, or uprooted afterwards in consequence of its being so thoroughly soaked by them, we see immediately that their deposition and sepulture, as well as the putting together again of the dislocated remains of the primeval earth, must have been an important part of the office of the subsiding waters, upon which I shall now offer a few observations.

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[1] *Genes.* viii. 4, 5.

It has been a matter of surprize that amidst so many fossil animals which are daily brought to light, and those of some of the largest quadrupeds in great numbers,[1] no remains of the *human race* have yet been discovered, except in one or two solitary instances. As the deluge was caused by the wickedness of these old *giants*, as they have been called, but really *apostates*,[2] these *men of renown*, it was evidently a miraculous interference of the Deity for their punishment; it seems, therefore, by no means improbable, that the place of their burial was not left to chance, or the uninfluenced action of physical causes, but, like the burial place of Moses, was decreed by God, and fixed so as to be placed beyond discovery.

It seems to have been the opinion of most modern geologists, that fossil animals in general were *natives* of those districts or countries in which their remains have been discovered. But whoever takes into consideration the account, above detailed, which the sacred writings give us of the universal deluge, and of the prevalence of the waters above the summits of the highest mountains, will see at once, with the exception of those that were overtaken and drowned by the waters in dens or caverns, they must have floated when the waters had reached and flooded all the elevations upon which they had taken their last refuge, and they would have drifted off north or south, or in any other direction the fluctuating element was taking, and if there was an alternate flux and reflux, they would have been carried by it backwards and forwards till they were deposited some here and some there; some upon mountain summits,[1] and others at different heights ruled by the circumstances of the earth's surface and the action of the subsiding waters. Few, indeed, would be imbedded in their *native* country, except those that perished, as above mentioned, in caverns; though probably, in many cases, those of the same species might congregate, and so floating off together might be buried together. It has been remarked that no fossil elephants have been found in the countries that those animals now frequent. It seems, therefore, by no means certain that the gigantic Saurians now found in our southern coasts, or that the Mammoths or other gigantic Pachyderms of Northern Russia or Nova Zembla, were really natives of those regions.

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[1] See *Reliquiæ Diluv.* 138—182.

[2] Heb. נפלים

What Geologist, then, however practised, however deeply conversant with his subject, can estimate and exactly calculate the action and operation of these mighty waters, both during their rise, prevalence, and subsidence for so extended a period; especially when those of an Almighty superintending and directing Cause, upon the whole body of means that he employed to accomplish his purposes, and execute his decrees with regard both to the destruction and renovation of our globe, are duly considered?

By what I have here argued I do not mean to contend that there may not have been many *partial* convulsions which may have produced very important changes in different countries of our globe: it is not moreover at all improbable that while its population was concentrated, many regions when uninhabited, God so willing, by diluvial, volcanic, or other action of the elements, might be materially altered, new mountain ridges might be elevated, mighty disruptions take place, and other changes to which there could be no witnesses, but which can only be conjectured by the features such countries now exhibit.

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[1] See above, p. 374.

Note 11, p. 41.—*We learn from the Apostle St. Peter, that the primeval globe, and its heavens or atmosphere, perished at the deluge.* I shall add a few words here on the passage of St. Peter alluded to in the text. Speaking of the scoffers of the last days, and of the deluge, *Whereby,* he says, *the world that then was being overflowed with water perished;* he adds, *But the heavens and earth,* which are now, *by the same word are kept in store,* &c. In this passage it must be observed that the term *world* in the sixth verse is synonymous with the *heavens and the earth* taken together of the fifth and seventh verses, and by it seems to be meant that the earth with its own heavens, or the atmosphere that surrounds it, both *perished* or were *destroyed,*[1] which is rendered further evident by the expression: But the *heavens* and *earth* which *are now.* From which it may be gathered that the heavens and earth *which are now,* are different from the heavens and earth which were destroyed at the deluge; and as the latter has evidently been reconstructed, and vegetable and animal remains have been mixed with the dislocated materials and as it were *detritus* of the original world;[2] so the new atmosphere might be, and probably was differently mixed, so as to be less friendly to health and longevity, which would account *physically* for the gradual reduction of the former extended period of human life to its present brief standard. Animals as well as man might be affected by this change, their bulk might be diminished, and other variations be produced in them which have not been ascertained. When God fixed upon the rainbow as the token of his covenant with Noah, the changes, here alluded to, in the atmosphere might be the cause of the appearance, under certain circumstances, of that phenomenon.

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[1] Gr. απωλετο.

[2] See above, p. 384, and Herschel in *Cab. Cyclop.* xiv. 141. No. 135.

Scientific men have judged it not improbable, without referring to this doctrine of Revelation, that changes in the composition of the atmosphere, according to circumstances, may have taken place.[1]

NOTE 14, p. 52.—*Whoever examines the animals of North America will find a vast number that correspond with* European *species—on the Rocky Mountains, and in the country westward of that range* Asiatic *types are discoverable.* The rein-deer, the fox, the weasel, the rat, the mouse, the golden eagle, the peregrine falcon, and many other birds are of the former description. In the latter paragraph I allude to a fine *Carabus*,[2] which is found in Siberia; and likewise to a new genus[3] related to *Trechus*, of which I possess a specimen, found in India, both taken also in the Rocky Mountains. Mr. Sabine informed me that several new Pœonias, and a Laurus that reached the height of sixty feet, were natives of the same country. In Chili, Molina found the green and temporary frogs, the heron, the turtle-dove, and several other old-world animals.

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[1] *Ann. Des Sc. Nat.* xix. 432.

[2] *C. Vietinghovii.* Fisch.

[3] *Isopleurus.* K. M. S.

Note 15, p. 54.—*But which in their immediate or remote consequences, may be productive of effects that are important to be attended to, and provided for.* When we reflect upon the action of the Deity, we can scarcely avoid taking our ideas of it, in some degree from that of man. Man's attention is usually directed to things that appear to him important, as affecting either his passions or his interests, but he passes by those that appear to him trivial, as having no bearing upon his pain, or pleasure, or welfare. But here there is a great difference, for though some

By long experience do attain
To something like prophetic strain,

the generality can trace the chain of causes and effects, but for a very few links; and therefore they disregard some things as trivial, which, in the event, produce effects of the greatest importance. But it is not so with God; he sees the most distant consequences of every thing that happens in his whole universe, and therefore knows exactly in what proportions every thing appertaining to the nature of every creature should be measured out to it in order to produce the effects he intends should take place, if I may so speak, during its ministration; so combining agents and actions, as may infallibly fulfil his law, and general purpose. He foresees the effect of what are regarded as the most trivial things, as the number of our hairs and the death of a sparrow, as well as of those that are most important: and his general object is to provide for the execution of the laws both physical and metaphysical by which he governs the universe, and so upholds all things, but not so as never to suspend the action of these laws. The following events recorded in Scripture were remarkable instances of such suspension.

Digitized

1. The *Universal Deluge*, by the means of which the heavens and the earth of the primeval world were destroyed.
2. The *Egyptian* palpable *darkness* for three days and nights.
3. The *passage* of the *Israelites* through the *Red Sea*, the waters standing as a wall on either hand.
4. The *sun* apparently *standing still* in the heavens at the command of *Joshua*, or the earth ceasing to revolve on its axis.
5. The *shadow going back* on the dial of Ahaz three degrees, or the earth retrograding.
6. The *supernatural darkness* that took place at our Saviour's crucifixion.

NOTE 16, p. 86.—*Which will take place in his time and at his word; and by the means and instruments that he empowers and commissions.* Ever since the fall of our first parents a copious harvest of evil and sorrow, the fruit of sin, has been reaped by their descendants, amongst others, that of *slavery* has been one of the bitterest. In the case of Ham it was predicted and decreed by the Deity himself that his son Canaan should be a *servant of servants* or *slave* to his brethren, a prediction which, to judge by the event, affected all the descendants of the offending patriarch, for no races have been so much degraded, in all respects, as the African negroes who derived their origin from him.

Much has of late been done with the view of ameliorating their condition, and most of the European nations have concurred in the benevolent endeavour. In consequence of the exertions of this country, the debasing traffic in slaves, and the miseries and waste of human life that it occasioned, have been very much diminished. But though

Christian nations have agreed to relinquish the trade in slaves, and it is to be hoped that many of the wars that were expressly kindled amongst the Africans themselves, for the purpose of making slaves will cease: still there are markets for slaves that we have no power to close, and therefore it is to be apprehended that the good expected from the abolition, by European states, of the traffic in question, will not be altogether realized: so that it still seems doubtful whether slavery is near its extinction, or whether it ever will be extinguished during the present state of society, and while the nations amongst whom it is practised continue to be apostates from the knowledge and worship of their Creator. While the souls of the sons of Adam are thus enslaved and sold under sin, it seems improbable that God's time for their general emancipation from bodily slavery should be at hand; but when their heart *shall turn to the Lord*, this, and numberless other evils, at his bidding, and by instruments that he appoints, will cease. The best way therefore of accomplishing this object is by providing means, wherever God has made an opening, for the education of the negroes, and for training them to habits of industry and order: to give them freedom before they are qualified to use it for the benefit of society, is giving them not a boon, but a curse.

NOTE 17, p. 87.—*Should another and last cloud of error envelope the world with darkness.* There are many passages of Holy Writ, from which it appears that, before the final triumph of the gospel, there shall be a time of great spiritual darkness upon earth; and it seems also to be intimated that this reign of evil shall be brought on by men that *Despise dominion, and speak evil of dignities*,[1] who shall promise *liberty* to their followers, while they themselves are *the servants of corruption;*[1] who shall resemble Corah, and his companions in rebellion Dathan and Abiram,[2] and rise up against their civil and ecclesiastical rulers; and who shall for a time prevail against them, as seems to be intimated by one of the most ancient prophecies in the Bible. *Dan shall be a serpent by the way, an adder in the path, that biteth the horse-heels, so that his rider shall fall backward.*[3] So says the venerable patriarch, in his valedictory and prophetic address to his twelve sons before his death. These words seem to foretell that serpents, or apostates, symbolized by the tribe of Dan, would, in the *last times,* incite the lower orders to rebel against their governors and reject their authority; and when Jacob adds *I have waited for thy salvation, O Jehovah,* it seems to be further indicated that this event will be followed by the great day of salvation. It was an ancient opinion that Antichrist would be an individual of the tribe of Dan, who, in the last times, to use the words of Irenæus, would leap like a lion upon the human race;[4] an opinion probably derived from this prophecy, or from that of Moses delivered on a similar occasion, *Dan is a lion's whelp: he shall leap from Bashan;*[5] and from the exclusion of that tribe from the number of those that were sealed, as recorded in the Apocalypse.[6] St. Paul, in his description of the man of sin, describes him as exalting himself above all that is *called God,* or that is *worshipped* or *venerated.*[7] This has been interpreted as meaning *idols,* but in *Scripture* princes and rulers are *called* Gods, as when it is said *Thou shalt*

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[1] *Jude*, 8.

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[1] 2 *Pet.* ii. 9, 19.

[2] *Numb.* xvi. 1—3, 31—35.

[3] *Genes.* xlix. 17.

[4] *Adv. Hæres.* l. iii. c. 38.

[5] *Deut.* xxxiii. 22.

[6] *Revel.* xvi. 5—8.

[7] Gr. *σεβασμα.* 2 *Thess.* ii. 4.

not revile the Gods *nor speak evil of the* ruler *of thy people;*[1] whence it seems as if St. Paul meant to indicate a power that was to exalt itself above all authority whether civil or ecclesiastical. Irenæus expected his personal Antichrist to reign three years and a half, interpreting the prophetic period of 1260 days literally;[2] but this period, if interpreted a year for a day, would only agree with a succession of individuals. The ancient opinion of a personal Antichrist, may be reconciled with the modern one of a succession of individuals entitled to that appellation, by considering St. John's prophecy of the two witnesses. They are to prophecy clothed in sackcloth 1260 days.[3] This period synchronizes with the reign of the Antichristian power which *corrupts the gospel*, headed by a succession of individuals. Again, they are to be killed, and their bodies exposed without sepulture in the street of the great city for three days and a half;[4] this second period synchronizes with the reign of the personal Antichrist, who *denies the gospel*, who is to be a single individual; and more particularly entitled to the name of Antichrist by his infidelity, and atheistic principles. *He is* the *Antichrist that denieth the Father and the Son.*[5] It may be asked—*When God doeth this, who shall be able to stand?* will any Christian church escape? We learn from the case of that of Philadelphia,[6] that if any such church holds fast her profession, has kept the word of Christ, and not denied his name, though beset by a host of enemies, she shall be kept from the hour of temptation.

Note 18, p. 87.—*And be restored to the favour of their God and their own land.* Some Divines have thought that there will be no restoration of the Jews to their own land; but as it is evident, from what St. Paul says, that they will at a period fixed in the Divine councils be converted to the faith of Christ,[1] so it appears equally clear, from what is foretold in the concluding chapters of Ezekiel and by other prophets,[2] that they shall also again inhabit Judea and Jerusalem. Some interpreters are also of opinion, that the pouring out of the vial of the sixth angel upon the river Euphrates and the drying up of its waters,[3] signify the dissolution of the empire of the Turks; that, by the Kings of the East therein mentioned, are meant the Jews; and that their return to their own land is indicated, by their way being prepared. Bishop Horsley supposes, likewise, that the eighteenth of Isaiah foretells this event, and that the great commercial nation of the day will be instrumental in bringing it about.[4]

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[1] *Exod.* xxii. 28.

[2] *Ubi supr.* l. v. c. 25.

[3] *Revel.* xi. 3.

[4] *Ibid.* 7—11.

[5] 1 *John*, ii. 22.

[6] *Rev.* iii. 7—10.

St. Paul's conversion is thought to have been a type of the conversion of the Jewish nation in the latter days, and as his zeal and success seem to have exceeded that of the other apostles, and he was the great instrument of the conversion of the gentile world to the faith of Christ, so it has been supposed that the Jews when converted, will be the main instruments of the conversion of the then heathen world.

NOTE 19, p. 88.—*Unless some means can be devised at home, by which the pressure may be lightened, and the suffering classes be enabled to procure the necessaries of life.* There are two mighty nations on our globe in which a system has long been acted upon, enabling them to support a population, never diminished by foreign wars, greatly exceeding that of any other country, whose numbers have only been diminished occasionally by famine, by devastating inundations and unfavourable seasons, from which nothing can altogether insure a people. The nations I allude to are China and Japan. We are informed, in the Account of Lord Macartney's Embassy, that in the former of these countries, "Every square mile contains upon an average one third more inhabitants, being upwards of *three hundred*, than are found upon an equal quantity of land, also upon an average, in the most populous country in Europe."[1] The population of the latter is also stated to be prodigious.[2] The encouragement of Agriculture appears to be the sole mean which enables these countries to maintain so vast a mass of population. In China, it is stated, that the whole surface of the country is dedicated to the production of food for man alone, that even the steepest mountains are brought into cultivation; they are cut into terraces, and the water that runs at their feet is raised by chain-pumps, worked each by two men, from terrace to terrace, to irrigate them; and steep and barren places are not suffered to run waste, but are planted with pines and larches.[3] A similar account is given of the state of agriculture in Japan, where attention to it is enjoined by the laws as one of the most essential duties; and if any one leaves his land uncultivated his more active neighbour may take possession of it. In both these countries no article that can possibly be used as manure is wasted, so that the soil and crops have every possible attention of this kind.[4] Malte-Brun has given a very interesting account of the honours paid by the Emperor of China and his court to agriculture: who annually in the beginning of March, after adoring the God of Heaven, and invoking his Blessing on his labour and on that of his whole people, himself, laying aside his imperial robes, holding a plough opens several furrows, and is succeeded by his chief mandarins, who in succession, follow the example of the prince.[1] Some allowance probably must be made for too warm colouring in these statements, as most of them must have been derived from the report of the natives, yet there seems no doubt with respect to their general accuracy. What an example is here set by nations which we are accustomed to consider as far behind ourselves in every art of life: how vast a portion of our own home empire is suffered to lie waste, while all the time hundreds of thousands of our agricultural population are languishing for want of employment, and compelled to live upon a pittance, which, unless they add to it by theft or fraud, is scarcely sufficient to keep body and soul together; and in the mean while the morals of our peasantry are gradually corrupted; they grow daily less industrious; they will often congregate at the beer-shops, and get inveterate habits of intemperance; they lose all respect for their superiors, and the bonds of union betwixt the upper and lower classes are gradually dissolving; and unless some remedy for this fearful evil is soon discovered, who can say what the consequences may be? When a man once loses his self-esteem, and is degraded from his natural dependence upon himself, under God, and the labour of his hands, for the support of himself and family, being no longer of use to himself or others, he becomes careless of his actions; and being, as it were, rejected by society, becomes the enemy of those above him, and the ready associate of evil men, in evil works.

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[1] *Rom.* xi. 25, 26.

[2] *Ezek.* xxxvii. &c. *Isai.* lx. *Jerem.* xxx. &c.

[3] *Rev.* xvi. 12. comp. ix. 14.

[4] See also lx. 8, 9, and *Zeph.* iii. 10.

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[1] Macartney *Embassy* by Sir G. Staunton, iii. 388.

[2] Malte-Brun. *Syst. of Geogr. Asia* II. ii. 533. E. T.

[3] Macartney *Embass.* iii. 386. Malte-Brun. *Asia*, 560.

[4] Thumb. *Japan*, iv. 82. Malte-Brun. 561.

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[1] Malte-Brun, 561.

NOTE 20, p. 156.—*Those that are loricated and covered with some kind of shell.* The varied means by which a provident and beneficent Creator has provided animals with different means of defence ought not to be overlooked. When we see even these invisible atoms as it were provided with armour, to defend them probably from the attack of animals of their own class, we feel confident that he will not neglect us. This distinction of animals into loricated and naked may be traced through most of their Classes; thus the *Coleoptera* stand in contrast with most of the other Orders of insects; the fishes and reptiles that are covered with scales with those that are covered with skin.[1] In birds, however, this distinction does not appear to obtain at all: in quadrupeds the giant *Megatherium*, the *Armadillo*, the *Chlamyphorus*, and the *Manis*, are distinguished from the other Mammalians by the armour that protects them.

NOTE 21, p. 162.—*The first plants and the first animals are scarcely more than animated molecules, and appear analogues of each other; and those above them in each kingdom represent jointed fibrils.* A discovery may here be noticed of one of the most scientific Botanists of the present age, and whose keen eye and philosophic spirit have penetrated into depths and mysteries before unexplored, belonging to the science of which he is so great an ornament. In the investigation of some of these, he discovered that not only vegetable, but even mineral molecules, when placed in a fluid medium, would move about in various directions, but by what cause these motions were generated he offers no conjecture. He very kindly shewed me this singular phenomenon, if my memory does not deceive me, with respect to some *mineral* substances. Mr. Brown has observed that the motions in question, he was satisfied, arose neither from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself;[1] and of the spherical molecules mixed with the other oblong particles obtained from *Clarckia pulchella*, that they were in rapid oscillatory motion:[2] in both mineral,[3] vegetable,[4] and animal substances,[5] along with the molecules, he found other corpuscles, like short fibres somewhat moniliform, or having transverse contractions, corresponding in number, as he conjectured, with that of the molecules composing them: and these fibrils, when not consisting of a greater number than four or five molecules, exhibited motion resembling that of the mineral fibrils, while longer ones of the same apparent diameter were at rest.[6] It does not appear clearly from the words of the learned author, whether the motion of the mineral molecules was similar to that of the vegetable ones, which he describes as oscillatory. The motions of the mineral fibrils, when not composed of more than two or three molecules, were at least as vivid as those of the simple molecule, and which from the fibril often changing its position in the fluid, and from its occasional bending, might be said to be somewhat vermicular;[7] now vermicular movement is a kind of progressive oscillation, the anterior extremity going from side to side and being followed by the body.

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[1] In some fishes the scales are invisible, so that they may be almost reckoned naked. Vol. II. p. 306.

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[1] *Brief Account of Microscopical Observations, &c.* 4.
[2] *Ibid.* 5, 6. [3] *Ibid.* 10. [4] *Ibid.* 11. [5] *Ibid.*
[6] *Ibid.* comp. 10, 11. [7] *Ibid.* 10.

In other mineral bodies, as in white arsenic, which did not exhibit the fibrils, he found oval particles about the size of two molecules, which he conjectures to be primary combinations of them: their motion, which was more vivid than that of the simple molecule, consisted usually in turning on their longer axis, and then often appearing to be flattened.[1] The revolution of a body upon its axis, it may be observed, implies the action upon it of two equal conflicting forces, by the counteraction of which the revolution is produced and maintained: the same action on the longer fibrils[2] would keep them at rest.

My motive for introducing a topic, which, at the first blush, seems to have a very slight connexion with the subject now before me, was a suspicion that sometimes Mr. Brown's molecules may have been mistaken for *Infusory Animals.* Comparing the oscillatory motion he observed in them, and Carus' observation that the motions of Infusories occasionally present the appearance of attraction and repulsion,[3] this suspicion seems to merit attention, and to call for more close examination; and it may be observed that the action of these two powers seems sufficiently to account for the oscillatory motions of the molecules, and takes away all idea of any spontaneity. With regard to the Infusories this has been most satisfactorily established in a former part of this chapter,[4] and this clearly proves their animal nature, as do their modes of motion, &c.[5] but when we recollect that they abound in vegetable infusions, and that the more vegetables are macerated, and as it were decomposed, the more numerous are the animalcula that they appear to give out when infused, it would be nothing extraordinary either that they should be mistaken for moving molecules, or moving molecules for them. Farther we may observe a kind of analogy between the spherical Infusories and the Molecules, and between the filiform ones transversely annulated with a vermicular motion, and the fibrils of Mr. Brown.

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[1] *Ubi supra.* [2] *Ibid.* 11.

[3] *Introd. to Comp. Anat.* E. Tr. i. 45. § 57.

[4] See above, p. 150. [5] *Ibid.* 153.

Another law of nature seems to result from the experiments of this acute naturalist—that all bodies whether organized or inorganized, are formed, as fibrin is in the animal kingdom, by spherical molecules made, as it were, into necklaces, and then adhering in bundles, and that these are the substratum of all substance. In fluids the spherules are not united, and so have free motion inter se.

NOTE 22, p. 198.—*Several of them, for it is not common to them all, when touched cause a sensation similar to that produced by the sting of a nettle.* Aristotle mentions a marine animal, under the name of *Acalephē*,[1] and another, if it be not the same, under that of *Cnidē*,[2] both of which words, according to the Greek lexicographers, are used to designate the same plant, the stinging-nettle;[3] but it seems not quite certain that, in either case, he had the stinging Gelatines or sea-nettles in his eye. Describing his *Acalephē*, he says, "It adheres to the rocks, as do some of the shell-fish, but sometimes it roves at large. It has no shell, but the whole body is fleshy. If the hand is moved to it, it perceives, seizes, and adheres to it, like the Polype, by means of its tentacles,[4] so that the flesh swells. It has its mouth in the middle, and the rock seems to serve it for a shell: if it meets with any of the small fishes, it detains them in the same way that it does the hand. Thus whatever edible thing it meets with, it devours. One kind of them is at large, and devours whatever sea-urchins,[1] or cockles,[2] it meets with: it appears to have no excrement, in this respect resembling plants. There are *two* kinds of *Acalephēs;* one smaller, and best adapted for the table; the other large and hard, such as are produced about Chalcis. In the winter their flesh is firm—they are therefore caught and eaten at that season—but in summer they dissolve, for they become watery, and when touched they immediately are so damaged as not to be removable.[3] When suffering from the heat they withdraw within the rocks."[4] And again—"It has a mouth in the middle, which is chiefly conspicuous in the large ones; it has, like the bivalve shell-fish, a passage by which the excrements are voided, which is in their upper surface: like them too it has the fleshy part within, but it uses the rock as a shell."[5]

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[1] Gr. Ακαληφη, Aulus Gellius (*Noct. Att.* l. iv. c. 11.) writes it Ακαλυφη.

[2] Gr. Κνιδη.

[3] Heschius explains Ακαληφαι by Κνιδαι.

[4] Gr. πλεκταναι.

With regard to his *Cnidē*, of which he treats at the same time with the sponges, as inhabiting the caverns of the rocks—he says, "Of the *Cnidēs* there are two kinds, one in the hollows, which adheres to the rocks; others, that range at large, are met with in smooth places,[6] and on the flat shore."[7]

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[1] *Εχινοι.* [2] Gr. *κτενες.*

[3] The word I have rendered watery (*μαδαρος*) means properly without hairs; but *μαδαω* is used by Theophrastus to express moisture, and is used here evidently in a similar sense.

[4] Aristot. *Hist. Anim.* l. iv. c. 6. [5] *Ibid.* l. viii. c. 2.

[6] In the text it is *εν τοις μειζοσι*, but Athenæus reads *εν τοις λειοις*, which better agrees with the context.

[7] Gr. *πλαταμωδεσιν*—it may perhaps mean flat rocks. Aristot. *Ibid.* l. v. c. 16.

It seems not accordant with the usual accuracy of this great Philosopher and Naturalist, where he is treating formally of the same kind of object, to distinguish it by two different names, nor is it likely that he would have placed them in separate chapters, as if they were distinct things. He would surely not have devoted one whole chapter to the *Tethys* and *Acalephē,* and another to the *Cnidē* and *Sponge,* unless he had meant they should be considered as distinct animals. Still there is one circumstance that seems in one respect to indicate their identity, one species of each appears to be usually fixed, and the other free. But this, by itself, does not furnish a satisfactory proof. With regard to these *Acalephēs* or *Cnidēs* of Aristotle having any right to be considered as belonging to Linne's genus *Medusa,* it seems chiefly based upon their name of *Nettles,* which probably was given them, from a faculty they possessed of stinging, in some measure, like a nettle, a faculty which some of the *Medusas* are known to possess in a remarkable degree.[1] But Aristotle does not appear to intimate that such an effect follows its touch, except that the fixing of its tentacles caused a swelling. If either of his species is entitled to be considered as a Medusa it must be the smaller; the larger or fixed one appears in one respect to resemble the *Amphitrite magnifica:*[2] they are stated to use the rock to which they are fixed as a shell, whence it should seem that they retire occasionally into it, like the above animal. With regard to his second species, though some parts of his description agree with the common jelly-fish, yet their devouring Echini and Cockles seems to indicate some animal furnished with a more powerful apparatus for making their way to the animal inhabiting these shells. Pliny does not in his description merely copy Aristotle; for he speaks of his sea-nettle as producing the same effect as the vegetable nettle. Yet he mentions them and the sponges as being something intermediate between the animal and the plant, which can scarcely apply to our Jelly-fish. It seems, I think, probable, that the term in question was employed by the ancients, to designate more than one group of animals, and more particularly the *Tunicaries* of Lamarck, both those that are fixed and those that are free. Aristotle's fixed species, which he describes as retreating into the rocks, as into a shell, will probably one day be found near the eastern coast of the Black Sea. It is worth while also to inquire whether any animal answering the description of Aristotle's second species is still eaten, in the winter, by the Greeks, customs of that kind seldom changing.

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[1] The stinging property of many such Tentacula, for instance, in the *Medusa* and *Holothuria,* likewise deserves notice. This, which, with some modifications, also exists in several plants, appears to be the lowest degree of the, so called, electric power in several fishes, not recurring in the higher orders of animals, and perhaps comparable as regards man, to the magnetic influence alone.—Carus. i. 47. § 60.

[2] *Tubularia magnifica, Linn. Tr.* v. 228. t. ix.

NOTE 23, p. 240.—*It seems to me most probable that they are the animals, and not the pholads, as is usually supposed, which the Roman naturalist describes under the name of Dactyle.* Pliny says of his *Dactyli* that they are so called, because of their resemblance to the human nail;[1] in the Pholads this resemblance is very slight, but in the rasor-shells and some tulip-shells it is much more striking. He also observes that the *Dactylus* when replete with moisture sparkles in the mouth of the eater, and that the falling drops also emit light.[1] If Pliny, in his account of this creature, was really speaking of the pholad, it is singular he should not mention its habit of boring rocks.

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[1] *Hist. Nat.* l. ix. c. 61.

NOTE 24, p. 252.—*Their byssus has long been celebrated, for it is mentioned by Aristotle.* Aristotle's mode of expression is singular. *Αἱ δε πιννι ορθαι φυονται εκ τȣ βυσσȣ εν τοις αμμωδεσι καὶ βοβορωδεσιν.* He says also when they are deprived of the pinnophylax, they perish.[2] Pliny, who mostly copies Aristotle's account, does not notice the byssus.[3]

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[1] His natura in tenebris remoto lumine, alio fulgere claro; et quanto magis humorem habeant, lucere in ore mandentium, lucere in manibus, atque etiam in solo et veste decidentibus guttis. *Ibid.*

[2] *Hist. Anim.* l. v. c. 16.

[3] *Hist. Nat.* l. ix. c. 42.

END OF VOL. I.

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